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INDEX TO VOLUME III.

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The Detection of Adulteration in Food.

BY C. M. VORCE, F. R. M. S.

V.—RED-PEPPER AND TURMERIC.

Next to black-pepper, red-pepper, usually called Cayenne pepper, seems to naturally deserve attention. This substance, which, from its name, many people suppose to be derived from a variety of the same plant which furnishes black-pepper, is the ground pod and seeds of a plant almost exactly similar in microscopical characteristics to the common, large red-pepper of our gardens, so extensively used for pickling. The commercial Cayenne pepper is chiefly prepared from the pods of the *Capsicum annuum*, although some other varieties of capsicum are occasionally used.

Pursuing with this, the plan adopted with other substances, we procure some of the unground, dry pods which we find to be thin, bright-red, conical pods with a slight oily feeling, divided lengthwise by a thin septum, usually into two, occasionally three, compartments, in each of which is a double row of flat, hard seeds overlapping each other like shingles. The pod of an especially fine sample of imported capsicum is shown in section, natural size, in fig. 1, plate I, and the seeds, also natural size, in fig. 2 *a*. The pod and seeds are extremely pungent and stinging to the tongue and the slightest touch will leave a taste for several minutes. The outside of the pod is smooth and shining to the eye, but the inner surface is covered with minute, short ridges, which instantly bring to mind the appearance of a very highly magnified podura scale. The appearance of this inner surface under a pocket magnifier, is shown in fig. 3, and that of the cut edge of the pod at *a* fig. 3. On examining a piece of the pod with an inch-objective, viewing it as an opaque object, the outer surface is seen to be smooth and glossy, composed of cells quite uniform in size, mostly quadrangular and arranged in longitudinal rows, irregular in places, but usually quite regular and resembling brickwork (fig. 4). The inner surface, which shows the ridges above referred to, is composed of very irregular cells, quite uniform in size, but with very sinuous outlines (fig. 5). The dividing walls of the cells appear sunken. On examining a portion of the pod in water by transmitted light, every cell appears filled with oil (fig. 6), and numerous minute drops of yellow oil are seen floating in the water (fig. 6 *b*). By a half-inch objective (of wide angle) the cells have the appearance of crowded oily drops (fig. 7). The true size and shape of the cells are not easily made out in this condition. Bands of spiral vessels, somewhat branched, but having a general longitudinal direction are seen in the substance of the pod (fig. 8).

On adding alcohol to the specimen under examination, most of the oil is dissolved, but it does not render the substance sufficiently transparent to clearly show the cells of the pod. In some places the cells of the surface show the contents reduced to a small central drop (fig. 4, lower part); this drop will not dissolve in alcohol even when heated, but by withdrawing the alcohol, and adding potash-solution

Fig 1.

Fig 2.

Fig. 3.

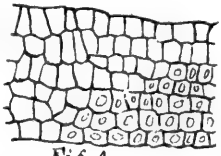
Fig. 4

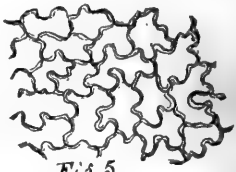
Fig. 5

Fig. 6.


Fig. 7.


Fig. 8.


Fig. 9.


Fig. 10.

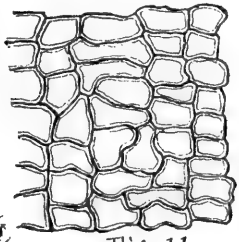
Fig. 11.

Fig. 12.

Fig. 13.


Fig. 14.

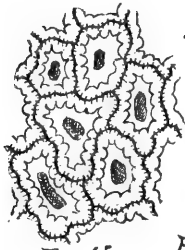
Fig. 15.


Fig. 16.

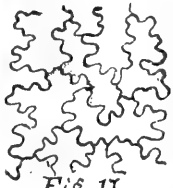
Fig. 17

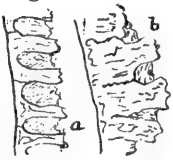

Fig. 18.


Fig. 19.

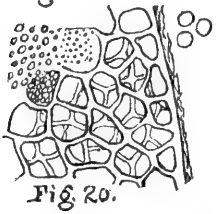
Fig. 20.


Fig. 21.

Fig. 22

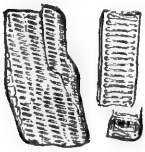
Fig. 23.

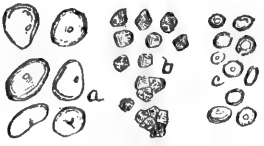

Fig. 24.


Fig. 25


Fig. 26.

Fig. 27.


Fig. 28,

PLATE I.

with gentle heat the object is cleared so that the cells are well seen. The cells of the outer surface have now the appearance of thick-walled cells of considerable depth (fig. 9), and the underlying cells can be made out as compressed, polygonal cells, somewhat larger than those of the outer layer, in several layers, with some granular contents still remaining and all having a deep-yellow color bordering on light-red.

The appearance of the inner surface is considerably changed by potash, the cell-walls being rendered indistinct in places, and the surface having a puckered and puffed appearance (fig. 10). A piece of the pod, macerated over night in potash-solution, becomes softened and swollen and is thus readily teazed out into separate elements. The cells of the substance of the pod, separated after maceration in potash, are shown in fig. 12 *a;* the cell-contents are greenish-yellow in color.

Upon cutting a thin, transverse section of the dry pod and examining it in water by one-inch objective, the ridges of the inner surface are seen to be hollow, like blisters, of a shining yellow color, and only attached to the substance of the pod at their edges; some are loosely filled with a colorless matter having the appearance of empty, collapsed pulp-cells, while some are quite empty (fig. 13 *a*). A clear, thin membrane lines the pulp-cells under the raised inner ridges (fig. 13 *b*). The substance of the pod is composed of small pulp-cells, originally oblong or roundish, now compressed by drying, and full of a yellowish, finely granular cell-contents having an oily appearance. The pod is from eight to ten or more cells in thickness, the layer of cells on the outer surface being quite distinct from the interior layers. The pulp-cells adjoining the space under each of the raised ridges of the inner surface of the pod are of a deeper, somewhat reddish color, for a depth of from three to seven cells, as indicated by dotted lines in fig. 13, where the pulp-cells are omitted from part

DESCRIPTION OF PLATE I.

Capsicum and Curcuma.

Fig. 1. Sections of pod of West India capsicum, natural size.

Fig. 2. Seeds of same: *a*, natural size; *b*, treated with potash; *c*, with nitric acid.

Fig. 3. Inner surface of pod slightly magnified; *a*, section of same.

Fig. 4. Outer surface of capsicum-pod x 73.

Fig. 5. Inner surface of same, dry, x 73.

Fig. 6. Capsicum-pod, untreated, in water, x 73; *b*, oil globules.

Fig. 7. Same, x 152.

Fig. 8. Spiral vessels of pod, in water, x 73.

Fig. 9. Outer surface of pod treated with potash, x 152.

Fig. 10. Inner surface treated with potash, x 152.

Fig. 11. Outer surface treated with nitric acid, x 250.

Fig. 12. Pulp-cells of the pod: *a*, treated with potash, x 73; *b*, with acid, x 250.

Fig. 13. Transverse section of pod, untreated, x 73; *a*, loose ridges; *b*, membrane of pulp; *c*, cells of pulp.

Fig. 14. Section of outer skin of pod treated with nitric acid, x 250.

Fig. 15. Inner skin of pod treated with nitric acid, x 250.

Fig. 16. Transverse section of seed, untreated, x 73.

Fig. 17. Surface of seed, showing shape of pits in the surface, x 250.

Fig. 18. Sections of shell and seed, x 250: *a*, treated with potash; *b*, with nitric acid.

Fig. 19. Thin membrane enveloping cotyledon of seed, x 250.

Fig. 20. Section of cotyledon of seed treated with potash, x 250, showing also starch of the seed, untreated, as seen by 1-inch, ¼-inch and $\frac{1}{10}$-inch objectives.

Fig. 21. Yellow starch-grains of turmeric, x 250.

Fig. 22. Light-colored starch (*a*) and cells of root-bark (*b*) of same, x 152.

Fig. 23. Spiral vessels of turmeric-root, x 250.

Fig. 24. Starch: *a*, of turmeric (?); *b*, of rice; *c*, of wheat found in ground turmeric, x 250.

Fig. 25. Scales of vegetable substance found in ground turmeric, x 152.

Fig. 26. Cellular tissue of turmeric with starch-grains, x 152.

Fig. 27. *A*, the yellow starch (Fig. 21), *b*, the white starch (Fig. 24 *a*) of turmeric treated with potash, x 152.

Fig. 28. Masses of earthy adulterants softened by water, x 250.

of the figure. The same drops of oil (fig. 6 *b*) are plentiful in the water surrounding the section, and the water is very pungent to the taste.

In a portion of the pod that has been macerated one night in nitric acid, the pulp-cells (fig. 12 *b*) are more swollen than those acted on by potash; the color is nearly all extracted, and the cells of the outer surface now show the separate layers of the cell-wall, the central, thickened layer being very distinct, and the thin, slightly wrinkled, inner layer, or primordial utricle, less distinct but plainly visible (fig. 11). A section of the outer skin of the pod, now easily separated from the pulp, shows the thickened framework of the cells cut across, and having a clear glassy appearance and a light-yellow color, in section, while the surface appears finely punctate (fig. 14). No cell-contents are present and no trace of the outer cell-wall forming the surface of the pod can be seen in the section, although it is readily seen in surface-view. A great number of sections were made and examined in the effort to discern the reason of this disappearance, but without success. The inner surface of the pod, after maceration in acid, presents an exceedingly beautiful appearance; being somewhat swollen, the crookedness of the cell-walls is thereby lessened, the secondary layer is very distinct, and the primordial utricle is festooned in loops and has exactly the appearance of being tied back at close intervals to the thick cell-wall, while the cell-contents are shrunken to a small globule in the centre of the enlarged cell (fig. 15). Under the microscope the inner layer of ridges, when untreated, appears of a clear, horn-like consistence, and to the fingers the pod seems tough and leathery, with a slight oily feel, and one instinctively wonders how it is practicable to grind it to a fine powder.

Passing now to the examination of the seed, which constitutes the greater bulk of this variety of capsicum-fruit, we find the seed covered with shallow pits of sinuous shape, separated by sharp-edged serpentine ridges shown in outline in fig. 17. When softened by maceration in potash, the seed appears to the eye as in fig. 2 *b*, and if macerated in nitric acid is still softer and more transparent, appearing as in fig. 2 *c*, in which the coiled radicle is visible to the eye by transmitted light. A transverse section across the seed, about its middle, examined in water by a one-inch objective appears like fig. 16. The hard seed-coat is of considerable thickness with the outer surface serrated and separated from the cotyledon by a thin membrane. The cells of the cotyledon are small, angular, and filled with granular matter; the transverse sections of the radicle are darker-colored, because composed of smaller cells with cell-contents more green. On squeezing out of one of the cut seeds the enclsoed cotyledon and crushing it on a slip in water, it is found to be enclosed in a thin, square-celled, hyaline membrane (fig. 19). The crushing of the seed sets free a cloud of minute, white, spherical starch-granules, which render the water cloudy, and are barely visible with an inch objective; by the quarter-inch objective they are seen distinctly, but not so as to reveal any hilum. These starch-grains are shown in the upper part of fig. 20, as they appear by half and by quarter-inch objectives, and three of the granules as seen by a one-tenth-inch homogenous-immersion lens, are shown at the right of fig. 20.

The outer seed-coat of a macerated seed, viewed from the outside, shows the outlines of the cells to correspond with the pits of the surface, as in fig. 17, in which the lines represent the sharp edges of the ridges separating the pits, which are very much deeper than in the dry seed. A section of the macerated seed-coat is shown in fig. 18. The membrane lining the shell of the seed, which is hyaline in its natural state, becomes

finely punctate after the maceration in acid (fig. 19, lower part).

A section of the cotyledon cleared of starch by means of potash, is shown in fig. 20. The cells are angular, thick-walled, smaller near the surface, and filled with minute starch-grains before treatment; one cell is figured with the starch-grains in place as they appear before the application of potash.

Treating successive portions of ground capsicum with the various reagents named, will bring to view all of the details of structure described above, and enable the genuine capsicum to be distinguished with certainty from its adulterants. Simply adding strong potash solution will often remove from view nearly or quite three-quarters of the substance under examination, and all of the capsicum will be found in what is left, as only its starch would be removed by the potash and would not have been observed in the first place unless a power of about two hundred diameters was used.

Ground Cayenne pepper in its commercial state is very largely adulterated. The pure capsicum is so excessively acrid that it is able to carry four or five times its own bulk of other substances, and still rank as a condiment. The adulterants chiefly used are turmeric, both genuine and spurious, starch of various kinds, both pure and in the shape of meal, and various ochreous earths to give weight. Red-lead is also said to be sometimes used, probably to restore the color lightened by the use of flour, but I have not seen it in any specimens I have examined. The best sample of ground Cayenne pepper that I could obtain was composed of about one-third capsicum, nearly one-third wheat-flour, a little rice-meal, and about one-third turmeric. This pepper was still so biting that what adhered to the dry finger would, when touched to the tongue, cause the peculiar burning taste of capsicum to linger for ten or fifteen minutes.

The chief adulterant, beside starch, is ground turmeric, the color of which is very near that of capsicum and which also has some degree of acridity. To determine the structure of turmeric, we should require a piece of the root in its uatural state, but this is by no means easy to obtain. I have visited many druggists at home, and also sent to other cities for it without finding it, and one druggist of many years' experience, whose specialty is botanical drugs, told me he had never seen the root except in powder, and volunteered the information that but little of the powder sold as ground turmeric is really curcuma at all. But having collected samples of so-called ground turmeric from a number of different sources, and finding them all to agree in certain microscopical characteristics, as well as in color, taste and smell, I conclude that there is really a good deal of powdered curcuma-root in the market after all. The figures 21 to 26 inclusive, show structures common to all the samples of turmeric examined, and omitting mention for the present, of structures found only in some of the samples, these structures (figs. 21 to 26), will be considered as representing genuine turmeric.

The color of turmeric is instantly extracted by alcohol while that of capsicum is not, hence it may be detected by this means without the microscope; on dropping a little suspected cayenne into one of two small vials of alcohol placed side by side before a light if any turmeric is present a yellow tint will be instantly manifest, its color depending on the amount of turmeric. The presence of earthy or metallic substances can be discovered by decantation in test-tubes. Starch is detected by iodine, or still better by the microscope. The starch of turmeric is large and of a clear, transparent, yellow color, in rounded, somewhat irregular grains, each of which occupies its own cell in the tissue of the root (fig. 26); but in ground samples it is mostly free or in

groups of three to six grains; various shapes of the grains are shown in fig. 21. These grains have a peculiar rough look on the surface which it is difficult to represent in a drawing. Different parts of the root differ somewhat in structure, as the starch-grains of one part are smaller, lighter colored, and smoother (fig. 22 *a*), while some portions, probably of the bark, exhibit cells of an oblong, rectangular shape, with finely punctate cell-walls (fig. 22 *b*). The spiral vessels are large and coarsely marked (fig. 23), and some of them appear nearly square. In all the samples of turmeric that I have examined, more or less starch from other plants was found, usually consisting of rice-starch (fig. 24 *b*) and wheat-starch (fig. 23 *c*) but in some samples I found also a large-grained starch (fig. 24 *a*) probably of some kind of arrow-root, or else from the white roots of turmeric, as this is sometimes sold as arrow-root. These granules are as colorless as wheat-starch, polarize with narrow bands, yet wider than potato-starch, and are somewhat less quickly dissolved by potash, but finally dissolve almost completely (fig. 27 *b*).

The yellow grains of the turmeric-starch are quickly and deeply stained by iodine as any other starch, but do not show so clear a blue color on the addition of sulphuric acid as do the whiter starches. The starch (fig. 22 *a*) gives a very deep clear-blue color by this process. Potash swells the yellow turmuric-starch to several times its former bulk, but the shape is still preserved and the sack-like membrane of the starch-grains remains visible even when heat is used (fig. 27 *a*). The yellow grains of turmeric-starch do not polarize in my hands with or without selenite. A quantity of thin, colorless, irregular scales, exhibiting no trace of structure (fig. 25) are seen in ground turmeric, but their origin is uncertain. The earthy adulterants consisting of small masses of aggregated granular particles (fig. 28) which separate by pressure into fine angular particles and disperse in the water, would easily be recognized by any observer as foreign to any vegetable substance.

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Examination of Blood-Stains by Reflected Light.

In the examination of blood-stains I have used with great satisfaction Beck's illuminator with a ⅛-inch objective.

With the aid of this instrument I have been able to examine and measure blood-corpuscles in place on a steel instrument that had been exposed in the woods for two winters. When the corpuscles are somewhat disintegrated, their form and dimensions are still clearly seen by this method.

I have a curiosity, in a legal point of view,—an axe which has lain in the open air in the forest three years, and which is but little rusted; some parts of it are quite bright and shining. I think no one would suspect that it had been exposed to the weather for even one winter.

Yours very truly,

MOSES C. WHITE, M. D.
Professor of Pathology in the Medical Department of Yale College.

NEW HAVEN, Ct.

——o——

The Bacteria.*

Billroth believes that all forms of bacteria are but different stages in the growth of a single organism, which he names *Coccobacteria septica*. He supposes that this organism exists in two forms, viz.: the coccus-form, when it appears as minute, round cells, and the bacteria-form when it is elongated or rod-shaped. He then distinguishes the different forms by their size. The coccus-forms are named micro-, mesa- and mega-coccus; the bacteria-forms are

* Abstract of some remarks by the President before the New York Microscopical Society, January 6th, 1882.

micro-, mesa- and mega-bacteria. Then, according as there are one, two or several cells united, he designates them as mono-, diplo- and streptococcus, or bacteria, as the case may be. When the bacteria form a scum upon the surface they form petalococcus or petalo-bacteria.

Davaine's classification, which is convenient, is as follows :—

Filaments straight, or bent, but not twisted.			Twisted.
A. Moving spontaneously.	*B*. Immovable.		
a. Rigid.	*b*. Flexible.		
Bacterium.	*Vibrio.*	*Bacteridium.*	*Spirillum.*

Dr. Luerssen has proposed the following classification, which seems to be excellent :—

I. Cells not in filaments, separating immediately after division, or in couples, free or united into colonies (Zoogloœa) by a gelatinous substance.
A. Cells dividing in one direction only.
a, cells globular : *Micrococcus.*
b, cells elliptical or shortly cylindrical : *Bacterium.*
B. Cells dividing regularly in three directions, thus forming cubical families, having the form of pockets strung crosswise, and consisting of 4, 8, 16, or more cells : *Sarcina.*

II. Cells united into cylindrical filaments.
A. Filaments straight, imperfectly segmented.
a. filaments very fine and short, forming rods : *Bacillus.*
b. filaments very fine and very long : *Leptothrix.*
c. filaments thick and long : *Beggiotia.*
B. Filaments wavy or spiral.
a. Filaments short and stiff.
a. filaments slightly wavy, often forming woolly flocks : *Vibrio.*
b. filaments spiral, stiff, moving only forward or backward : *Spirillum.*
b. Filaments long, flexible, with rapid undulations, spiral through their whole length, and endowed with great mobility : *Spirochæte.*

Billroth's classification is commendable for its simplicity, but there are facts to be mentioned further on which tend to prove that some of the different forms of bacteria are distinct species. Nägeli follows Billroth to some extent. He finds that forms, precisely alike in their appearance under the microscope, occur under very different conditions, and produce different effects. He therefore supposes that they have become adapted to the different conditions in which they are found, and recent experiments afford no little support to this idea. Cohn, supported by Pasteur, Koch and other competent authorities, declares that there are well-defined species of bacteria, which are characterized by physiological phenomena peculiar to themselves.

Taking the evidence as it stands now, as far as it is familiar to the speaker, it seems clear that there are distinct species; but any single species may be found in such totally different forms, that the identity of the forms cannot be determined without a study of the growth and propagation of the particular specimens under examination. Thus, *Bacillus anthracis*, in a certain stage of its growth, produces spores which cannot be distinguished by their appearance from micrococci. These spores, however, do not multiply by division like micrococci, and they are not killed by a temperature which is fatal to the latter. The necessity of a knowledge of the life-history of these forms in naming them is, from this fact, apparent.

In opposition to Cohn's views, the experiments of Prof. Law may be cited, which tend to prove that by cultivation alone, a harmless species can be made virulent, while an infectious species can be made entirely harmless.

Motion of Diatoms.

The article in the last JOURNAL from Dr. Geo. M. Sternberg, confirming Dr. Wallich's view relative to the motion of Diatoms, is interesting to all who have studied the subject. He says: "Dr. Wallich ascribes these motions to the existence of prehensile filaments capable of alternate extension and retraction, of extreme tenuity, yet of extraordinary strength and elasticity." Dr. Sternberg has not been able to see these filaments in living diatoms, and therefore cannot verify the assertion. His method of instantly terminating the life of diatoms is both interesting and unique; but, judging from the instantaneous contraction which has taken place in the many animal and vegetable objects which I have attempted to prepare for mounting, I am surprised that he succeeded so well. About eight years ago I was in correspondence with Prof. H. L. Smith concerning the motion of diatoms, when he called my attention to certain filamentous growths, hairs, or pseudopodia, long and very slender, proceeding from the edge of *Stephanodiscus Niagaræ*. Sometimes they were twice as long as the diameter of the diatom. No one had seen them but himself at that time, and he had only observed them two or three times. In a few weeks I was gratified by finding the same attachments in a gathering which I made from the water-supply from Niagara River.

I still have some of them mounted on a slide which shows them very distinctly. In 1876 I sent the slide, with others, to microscopists for their examination and opinion as to the nature of the filaments. Those of them who ventured an opinion were inclined to consider them pseudopodia. I quote from one correspondent, Mr. Geo. W. Morehouse, who says: "Certainly there is strong resemblance to pseudopodia. Did you detect any motion of the pseudopodia while the diatoms were living? * * * On the whole the resemblance to pseudopodia is greater than to anything I know of. Plants do not possess true pseudopodia, but, in the lower forms, are there not some families of plant-animals, possessing some characteristic of both animal and plant? Is it possible in all cases to distinguish between protoplasm and sarcode? * * * I consider your discovery of considerable importance, and hope you will give the facts to the public." I have not done this, except as above indicated and also by showing the slide to a few individuals. I have been waiting for more light. Now, if Dr. Wallich and Dr. Sternberg have been able to photograph or prepare diatoms in any other way, showing any indications of these filaments, whether prehensile or not, it would give me great pleasure to have an opportunity to compare their specimens with mine. For my own part, I have been inclined to regard the filaments as a parasitic fungus, but this may be far from the truth. There is one fact, however, that must be borne in mind, viz.: that *Stephanodiscus*, like all the discoidal diatoms, has very little motion, if any. Then, what are the filaments for, if they are a part of the diatom? I have observed another point of great interest in the study of this subject, and it may ultimately help to throw light on it. In my continued examination of the diatoms found in the Niagara water-supply, I have at times found the smaller discoidal diatoms, such as *Orthosira*, *Melosira*, and some of the genus *Cyclotella*, in great abundance. These were stationary, of course; but on the slide, under the cover-glass or not, they would repel every light-body, and all the debris from contact with them, so that a distinct annulus, clear and well defined, would be formed around them. The width of the annulus was about equal to the diameter of the frustule. This phenomenon may be witnessed by any who are so fortunate as to collect this

class of diatoms alive. The experiment may be made beautifully demonstrative by the application of a little soluble blue under the cover-glass, with the drop containing the diatoms. Whether this phenomenon is the result of cilia too minute to be seen, or of motion of the chlorophyll-grains inside the diatoms, I could never determine, though I have watched for hours. Unfortunately, a change in the character of my water-supply has deprived me of the means of continuing these investigations; I cannot now find the diatoms. I would say further that I have shown this object to many microscopists and to the microscopical club of this city. I would be glad to hear from any who may have a word to say on this subject

HENRY MILLS.

BUFFALO, N. Y.

The Griffith Cell.

BY E. H. GRIFFITH.

The following method of making cells, which I think originated with myself, I have for many months used with more satisfaction than any other. I am pleased to learn that the method is also very popular with microscopists in many States to whom I have explained the process. Place the slide on a turn-table, and with white-zinc cement turn a circle on the centre if for a transparent mount, or a disc if for an opaque one, then to the circle or to the disc centre a common curtain ring and immediately paint the ring with the cement, taking care not to push it from its position. When dry, the cement will hold the ring very firmly so that there need be no fear that it will break off. If a shallow cell is desired the rings may be flattened easily; or, if a deep one is required, several rings may be securely fastened one above the other by painting each one in succession, in the same way that Mr. Walmsley makes his excellent wax-cells. If the cement does not flow readily add benzole; and in case the cell becomes rough, dip the brush in clear benzole and smooth it. Use a brush well filled with the cement to secure a smooth background. With a little practice a person may easily make fifty beautiful and practical white cells in one evening, and in a few hours they will be hard and ready for use. When the cover-glass is to be fastened a little of the cement is easily applied. When dry the slide may be finished with colors prepared from tube paints mixed with benzole-balsam, or with damar and benzole. Before mounting, if a dark background is desired, I know of nothing better than a disc of asphalt of any desired size turned in the centre of the ring. Over the asphalt a small sized cover-glass may be used for the object to be placed upon, or the asphalt may be covered with shellac when dry. The object may be fastened with gelatin or gum arabic, or made to adhere to the coat of shellac before it becomes dry.

The New "Congress" Stand.

This stand, made by Mr. W. H. Bulloch, of Chicago, is supported by a broad, flat tripod. Upon the upper portion of this tripod rests a thick, circular plate, from which rise two stout columns that support the body of the instrument. The plate rotates upon the tripod, but it can be clamped in any position by a screw with a large milled head. The edge of the plate is silvered and graduated to degrees.

The body of the instrument is suspended at the top of the columns by two trunnion joints. It can be inclined at any angle from vertical to horizontal, and can be clamped by a pair of screws. The limb has an unusually long and broad slide, more than an inch in width by about six inches in length. Near its outer edges are two V-shaped grooves extending the whole length of the slide. The centre of the slide is cut out into a

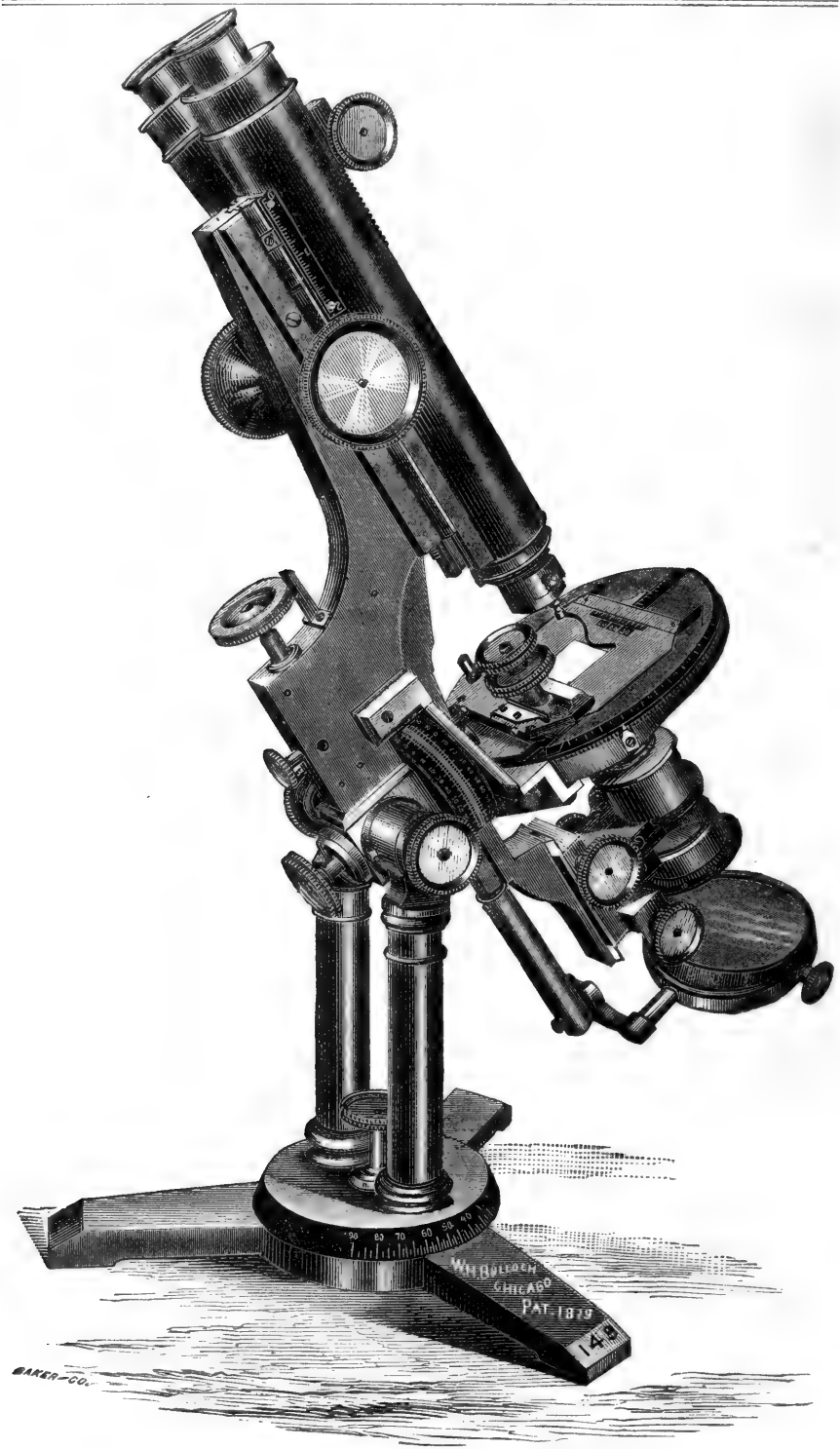

FIG. 1.—THE "CONGRESS" STAND.

deep groove to receive the rack; the sides of this groove are undercut with secondary grooves at right angles with the first.

A rib considerably longer than the slide on the limb is attached to the tube. This rib fits upon the slide; from its centre projects a secondary rib, which bears the rack. On each side of the rib which holds the rack are two small ribs, which fit into the V-shaped grooves of the slide; they are the bearing surfaces of the tube. From each side of the secondary rib which carries the rack, project two flanges, which fit into the under-cut grooves in the deep groove in the centre of the slide. Their purpose is to keep the small ribs closely applied to the V-shaped grooves.

The fine adjustment is behind. A piece about three inches long is cut out from the centre of the slide, which contains the pinion. A small piece is cut off from the end of this piece, so as to allow a motion of about an eighth of an inch. A strong spiral spring is placed above this to keep it pressed down to the bottom of its slot. It can be raised by a lever which is acted upon by the milled-head of the fine adjustment. By turning this screw the lever acts upon the piece containing the pinion and moves it, and with it also the tube. The milled-head is provided with an index and subdivided in such a way that turning the screw past one division will move the tube one-thousandth of an inch. The usefulness of this device is still further increased by a scale subdivided into

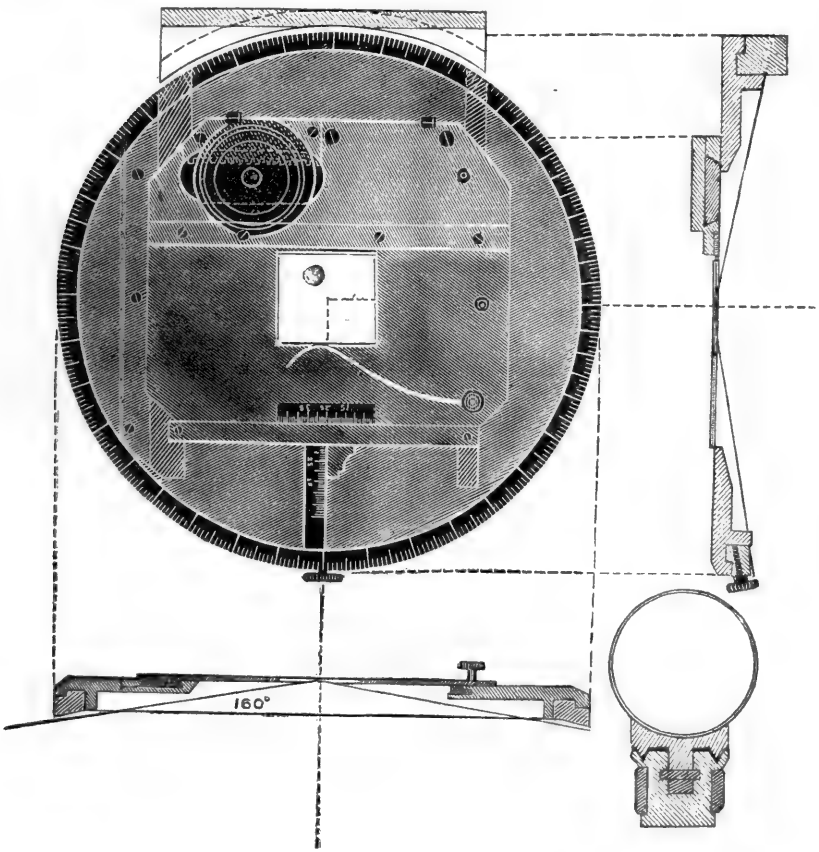

FIG. 2.—STAGE OF THE "CONGRESS" STAND.

hundredths of an inch, attached to the limb where it joins the tube.

With a magnifying power of about 2,000 diameters used on this stand, there is not the slighest apparent displacement of the object by any motion of the fine adjustment, and the working of the screw-collar, is accomplished with the greatest ease.

The nose-piece carrying the Wenham prism is readily removed and another one substituted having no diaphragm.

The substage and mirror are attached to bars, both of which swing on a pivot around the object as a centre; they both have a silvered and graduated limb, and can be swung together or separately. When these two bars are brought together they are held by a spring stop; another spring stop indicates when they are brought to the centre.

The swinging substage may be used for measuring the angular aperture objectives. This method consists in attaching a small lamp to the substage and using it as a source of light for observing some object upon the stage of the microscope. By gradually swinging the substage and lamp until the image disappears, we have measured all the usable angular aperture of the objective. The substage is moved up and down upon its bar by a rack and pinion, as usual. Its centering arrangement is placed behind the ring, and consists of a rack and pinion, and a screw similar to the movement of most mechanical stages. It has a motion from side to side of about half an inch, and a quarter of an inch forward and back. An arm beneath the stage holds the hemispherical lens or Woodward prism. This arm can be removed. The lens or prism can also be placed in the substage. In the latter they can be centered with great ease. Below the substage is a ring to hold the polarizer. This ring swings to one side, enabling the observer to examine an object alternately with polarized and unpolarized light, without trouble or disturbing the object.

The stage is held by a saddle-piece which is steadied by a strong brace passing down from the limb. It is entirely independent of the swinging of the mirror and substage. This saddle-piece contains a set of screws with perforated heads for centering the ring which supports the stage. By removing these screws so far back the ring can be very much reduced in thickness without impairment in strength or stiffness. The stage rests upon this ring. It rotates and can be centered with the greatest exactness by the screws in the saddle-piece.

The stage is a revival of an idea which Mr. Bulloch says was applied by Spencer thirty years ago. It consists of the ordinary stage-plate, having in its centre a large square hole. One side of this plate contains a wide dove-tailed groove. In this groove slides a bar with its surface level with the top of the plate. At right angles to this bar is attached another bar. On this second bar slides a third bar, into which it has been dove-tailed. The motion of this third bar is, of course, at right angles to the motion of the first. A thin plate is attached to the third bar and lies flat upon the stage-plate. This plate is perforated and holds the slide by means of a spring. It will be seen that this arrangement permits of motion of the thin plate in two directions at right angles to one another. Two pinions, perpendicular to the stage, which work one through the other, and act upon racks placed at right angles, effect this motion. Scales placed at right angles serve the purpose of finders.

This form of stage presents several advantages. It is convenient. The perpendicular milled-heads of the stage-motion are within easy reach of the hand, and from them a change can be made to the milled-heads of the coarse or fine adjustment, without thought or trouble.

The motion of the stage is very easy and rapid; an animalcule can

be followed, however swift or tortuous its course may be. It permits a complete rotation. There is no machinery underneath to interfere with the course of the light. The stage may be made extremely thin. In this stand light may be admitted at an angle of something more than 160 degrees.

The stand has also an arrangement for drawing, suggested to Mr. Bulloch by Dr. Lester Curtis, which is designed to do away with some of the difficulties attending the use of the ordinary camera lucida. A little table is fastened to the limb by milled-head screws. Paper is placed upon this for drawing. One of Hartnack's right-angled camera lucidas is used. Drawing can be done in any position of the microscope. There is hardly more preparation required for this than would be required to change an eyepiece. The comfort of this arrangement, when one is doing work which requires much drawing while observation is going on, needs to be experienced to be appreciated.

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Large vs. Small Stands.

I must thank you Mr. Editor, for your criticism of my remarks on stands in your November number. You have undoubtedly done the best you could for your side of the question, and that is very little. As the matter is one of the first importance to all investigators, as well as to those who are to be the investigators of the future, I must ask the privilege of criticizing my critic, and allow me to remind you that this is not a new subject with me; I fought the same battle with Prasmowsky in the *Lens* several years ago.

You now ignore the main question which I endeavored to make prominent: "There can be no doubt that the time of large and costly microscopes is passed. Indeed, there will be always some that will want them, but the experienced worker, whether he be an amateur or a professional, will surely discard them."

It is this teaching that I reject, and claim ought to be rejected; and I claim also that it is rejected.

Now I know that there are persons, not only in Europe, but in America, who think and talk as you do; but I do not know that any one of them has any experience of the difference of vision between the common German model and the full-sized ten-inch tube of English and American instruments. As I said before, the whole use of the microscope is to see with, and considerations of cost or convenience must be secondary to seeing best. It does not follow that the full-sized Jackson model should be very costly, further than two pounds of brass cost more than one pound. Of course, some persons need or wish for, appliances that cannot be used at all, or not efficiently on the short stands. That is another matter, I am claiming the time of large microscopes is not passed.

I utterly deny that the small stands "are more convenient." Any use of a microscope is a matter of delicate manipulation, and it is equally convenient to take a sixteen pound microscope from its case, where it stands vertically ready for use, as it is a four pound one.

You say, "We have in no place especially commended the German model, but we wrote of 'low stands not much higher than the German model.'" Precisely that I, and I presume every one, understands to be a commendation of the German model, and my objection is not especially to German, but to any not much higher.

My omission in the quotation that you refer to, was intentional; I was not, in that passage, considering the minor question of convenience, but the great all-important one of superiority of vision which, practically you surrender.

To conclude, if any yet claims that the time of large microscopes—mean-

ing by "large," ten-inch tubes and ten to sixteen pounds weight "has come," let them accept my proposition of the demonstration of superior optical performance, or forever after hold their peace.

The question is not for argument, but one of fact.

CHARLES STODDER.

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Cleaning Diatoms.

I offer the following suggestion for cleaning diatomaceous material when largely contaminated with sand. A quantity of the material is placed in a teaspoon, and water is then added until the teaspoon is nearly filled; the spoon is gently shaken with a back and forth or a circular motion, for a few seconds or longer, when the water must be quickly drawn off by applying the tip of a finger to the point of the spoon, taking care to draw off the superficial water, without allowing the heavier sediment to pass over the point. Pour from the spoon into a watch-glass, the surplus water is then drained off, and the diatoms removed for mounting. This method produces a magical concentration of the diatoms, large and small, making the remaining sand inconspicuous by the superabundance of the diatoms.

K. M. CUNNINGHAM.

EDITORIAL.

Subscriptions.—Remittances for subscription should be made by post-office money-order, by drafts payable in New York, or in registered letters. Money sent in any other way will be at the sender's risk. A receipt will be immediately given for money received by open mail.

BOSTON WATER.—The report of Prof. Ira Remsen on the Boston water, referred to last month, has been published by the city of Boston. It is illustrated by a colored plate representing the fresh-water sponge, *Spongilla fluviatilis*, with a transverse and a longitudinal section of the sponge. A letter from Prof. Farlow is also printed, who expresses his belief that the "cucumber odor" is not due to any vegetable growing in the water. Prof. Remsen's conclusions, which were quite fully stated in our December number, were combated by a number of gentlemen at a meeting of the Boston Society of Natural History, but we are still inclined to the belief, after carefully reading his official report, that they will be verified by future investigations.

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MICROSCOPICAL SOCIETIES.—We have heretofore followed the established custom of publishing the reports of microscopical societies as they have been furnished by the secretaries, omitting matters of a purely business nature, or such as were only of local interest. This course has, for various reasons, been more or less unsatisfactory; for we have felt that the space occupied by the reports, while too small to admit of full notices of the meetings of all societies, could be filled with matters of greater general interest and importance if the reports were condensed and given in a different form.

We have, therefore, decided to adopt a different plan this year, which, although it will add to the labor of editing the JOURNAL, will, nevertheless, we believe, prove more satisfactory to subscribers and also to the members of the societies.

We propose to take the reports of meetings that may be sent to us each month, read them carefully, and embody the most instructive and interesting features of them all in a single article, as in this number. This plan will doubtless make the reports more readable, and it will afford us an opportunity to offer occasional suggestions and criticisms. Under the former plan we were occasionally obliged to print erroneous observations or conclusions without comment,—we can now indicate these without offence to the authors, for even the best of us are liable to make mistakes, and we have not the slight-

est doubt that the new plan will prove more satisfactory to the societies than the old one.

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ANIMAL VACCINATION. — In an article published in *Popular Science Monthly*, Dr. W. B. Carpenter has presented this subject in the following language :—

"Thus, then, it becomes possible to affect sheep and cattle with a form of anthrax-disease so mild as to bear much the same relation to the severer forms that cow-pox bears to small-pox; and for this artificial affection with the mitigated disorder, Pasteur uses the term 'vaccination.' The question that now arises—to which the whole previous investigation has led up—is the most important of all: Does this 'vaccination' with the mild virus afford the same protection against the action of the severe, that is imparted by cow-pox vaccination against small-pox? To this question affirmative answers were last year obtained by Professor Greenfield (on Professor Burdon-Sanderson's suggestion) in regard to bovine animals, and by M. Toussaint in regard to sheep and dogs; the former, when vaccinated from rodents, and the latter from fluids cultivated outside the living body after a method devised by M. Toussaint, proving themselves incapable of being infected with any form of anthrax-disease, though repeatedly inoculated with the malignant virus, and remaining free from all disorder, either constitutional or local. The same result having been obtained from experiments made by Pasteur himself, probably about the same date, with charbon-virus cultivated in the manner previously described, it was deemed expedient by one of the Provincial Agricultural Societies of France that this important discovery should be publicly demonstrated on a great scale. Accordingly, a farm and a flock of fifty sheep having been placed at M. Pasteur's disposal, he vaccinated twenty-five of the flock (distinguished by a perforation of their ears) with the *mild* virus on the 3d of May last, and repeated the operation on the 17th of the same month. The animals all passed through a slight indisposition, but at the end of the month none of them were found to have lost either fat, appetite, or liveliness. On the 31st of that month, all the fifty sheep, without distinction, were inoculated with the *strongest* charbon-virus, and M. Pasteur predicted that on the following day the twenty-five sheep inoculated for the first time would all be dead, while those protected by previous vaccination with the mild virus would be perfectly free from even slight indisposition. A large assemblage of agricultural authorities, cavalry-officers, and veterinary surgeons having met at the field the next afternoon (June 1st), *the result was found to be exactly in accordance with M. Pasteur's predictions.*"

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CONTAGIOUS DISEASES OF ANIMALS.—Special Report No. 34 of the Department of Agriculture, contains several valuable contributions to the knowledge of diseases of animals, to which we cannot do justice in the space at our disposal. However, some of the investigations recorded in the report deserve especial mention here; among them those of Dr. D. E. Salmon, on swine-plague and fowl-cholera. After recording some experiments upon the efficiency of certain disinfectants in destroying the virus of swine-plague, some microscopical investigations in regard to the nature of the virus are quite fully detailed.

Dr. Salmon finds a *Micrococcus* in the blood of animals affected with swine-plague, which he regards as the possible cause of the disease. However, the precise relation between the disease and the organisms referred to is clearly stated as follows, quoting from Dr. Salmon's report:—

"If, in conclusion, we admit the presence of a particular bacteria-form in the effusions, or even in the blood, in the disease, the facts already referred to in regard to the presence of such organisms in non-contagious maladies, often before death, renders it necessary that a connection be established between such bacteria and the contagium; certainly no satisfactory connection or identity has been shown to exist between the bacteria and virus in this disease up to the present time."

There are many interesting observations described in this report, and

a valuable review is given of the whole subject of bacteria and their relation to diseases; but we cannot now notice them more fully, and the reports of Drs. Law, Detmers, and others, must be passed over with only this reference. There is also printed a translation of some articles by M. Pasteur, and by others, read before the French Academy of Sciences concerning the etiology of charbon.

The importance of these investigations, conducted by the Department of Agriculture, is not readily overestimated, and the liberality with which the illustration and publication of the reports is provided for, indicates that the value of the thorough scientific study of such diseases, to the agricultural and commercial interests of the country, is fully recognized by the Department. These investigations require not only the best instruments for observation, but also a thorough knowledge of the subject on the part of the investigators, combined with skill and experience as observers. The reports of the Department already show that the truly scientific method has not been followed by every investigator who has been entrusted with the microscopical study of the schizophytes of disease. Hasty and erroneous conclusions have been reached, where a more profound knowledge of the work of others would have been a safeguard against them. But on the whole, the work has been well done, and we trust it will be continued in a manner as satisfactory as it has been in the past.

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Large and Small Microscopes. —Mr. Stodder is so persistent in his arguments on this subject, that we deem it worth while to present the opposite side more fully than heretofore, indicating the reasons for the position we have taken. We have supposed our readers would see clearly enough, why a small stand, if it can be made to do the work of a large one equally well, is more convenient than the latter, and we have not, nor do we now, deem it worth while to spend any time in the discussion of that question. But Mr. Stodder denies even this. We will not attempt to demonstrate that he is in error, but willingly leave the decision of a mere matter of opinion like this to the judgment of our readers.

Mr. Stodder seems to think small stands are necessarily made with short tubes of small diameter, and that they cannot be used for all purposes. But in this, he is quite wrong. By a small stand we mean one about the size of Mr. Bulloch's "Biological," and, as for the size of the tube, we would have it of the standard which may be recommended by the American Society of Microscopists, whatever that proves to be. The length of the tube is a matter of comparatively little importance. It may be ten inches or it may be less. We think it should be ten inches with the draw-tube out, merely because English and American objectives are corrected for tubes of that length. Lest there should be any misapprehension about the advantage of a large over a small tube, it may be said that for each focus of ocular, there is a certain limit for the diameter of the tube, beyond which there is no advantage in further enlargement. If we established a definite focus for an "A" ocular, then the best size for the tube will be just large enough to utilize the full aperture of the field-lens of that ocular. Practically, there is a limit to the diameter of the field-lens. Hence a tube exceeding that limit affords no advantages. But as the higher oculars are used, the available diameters of the field-lenses become smaller. Hence, a "B" ocular does not require, for perfect action, so large a tube as the "A;" the "C," does not require one so large as the "B," etc. It is probable, therefore, that the standard size of tube, if ever adopted, will be determined by the "A" ocular.

We are now in a position to under-

stand the force of Mr. Stodder's assertion that he could display objects better on a large stand than upon a small one,—meaning one with a small tube. Undoubtedly this is true with low oculars; but with higher oculars it is not. However, we do not wish to have on our small stands a tube of smaller diameter than the "A" ocular requires, so further discussion of this subject is not necessary.

In writing upon this subject at first, we did not allude to the advantages of a large tube, simply because the display of objects is rather a secondary consideration, from a practical point of view. All the work of investigation requiring the use of high-power objectives, and careful examination, can be done, satisfactorily and accurately, with small tubes. Let us not forget what continental observers have done, and are now doing, with small tubes.

If the reader will now turn to page 114, Vol. II, it will be seen that Mr. Stodder claims certain advantage for large stands in the use of accessories and in illumination. We may admit that most small stands now made, are not adapted to the best display of objects. But this fact by no means controverts our assertion that small stands are the best—it only shows that they are not yet made as they should be. For it is certainly true that a small stand can be made to do all that a large one will, just as well and more readily. For delicate work a large mirror is more difficult to use than a small one—let anyone who doubt's this statement, test it by experimenting on *A. pellucida* with a Woodward prism, and a large and a small mirror. In a small stand everything is conveniently at hand. The fine-adjustment is not too high for comfort, the substage is not too far away.

We do not speak without practical experience in this matter, having used for years a very large microscope exclusively, and afterwards a small one.

The favorite stand of the future, the most salable one, and the one that is destined to displace the tall, showy instruments now so largely used, will be a small, compact microscope, with which any microscopic work can be done.

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Proceedings of the American Society of Microscopists.—The proceedings of the Columbus meeting have recently come to hand. The volume contains 100 pages of printed matter and seven plates. As we have already given a brief account of the meeting, soon after it was held, an extended notice of the articles is not called for at this time, especially as the volume itself can be obtained for $1.10 from Mr. Geo. E. Fell, of Buffalo.

Dr. A. M. Bleile has a short but valuable contribution on the innervation of the lungs with a plate. Dr. Lester Curtis has taken a strong position against the teachings of Drs. Heitzmann and Elsberg, of this city, who are supported by a few other observers, concerning the net-work structure of protoplasm. We trust that he will have still more to say upon this subject, for although most histologists are inclined to ignore the ill-founded "bioplasson doctrine," it is well known that grevious errors will readily become fixed in the minds of students and others, if no efforts are made to refute them. Mr. Vorce has a list of the organisms found in the water of Cleveland, and a few interesting observations about the periodicity of their development. A plate containing one hundred and ninety-two figures accompanies this article. Dr. Blackham discusses the question whether homogeneous-immersion objectives should be made adjustable or non-adjustable. He thinks they should be adjustable and gives his reasons. Mr. Geo. E. Fell has an interesting article about the binocular microscope and stereoscopic vision. Our criticism of that article is, that since, in our opinion, the subject is one which requires more thor-

ough scientific investigation than it has yet received from any competent person, it is too early to reach any definite *à priori* results. We believe many of the opinions that now prevail regarding stereoscopic vision with the microscope are destined to be materially changed in the future. Nevertheless, Prof. E. Abbe is not a man whose assertions or observations are to be lightly thrown aside, and Mr. Fell would do well to read carefully his discussion of binocular vision with the microscope, as published in his "Beschreibung eines neuen Stereoskopischen Binoculars," before venturing to criticise his conclusions too severely.

The volume is well worth the price for which it is sold, and we think all our readers would find something to interest them in it. The Society seems to be in a flourishing condition: The Treasurer's report shows a "possibly available balance" of $574.56, of which $385.81 was cash on hand on August 11th, 1881. There are one hundred and fifty members on the list.

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Fossil Organisms in Meteorites.—Perhaps some readers thought we were rather hasty in our recent allusion to this subject, but Dr. Hahn's published conclusions seemed to us to bear upon their face the evidence either of insufficient or incompetent observation, coupled with a vivid imagination. We have since made some inquiries as to the opinions of such eminent authorities as Prof. R. P. Whitfield and Dr. J. S. Newberry, and we learn that they are also sceptical regarding the discovery; and Prof. J. Lawrence Smith, who certainly ought to know as much about meteorites as anybody, has declared that the nature and composition of the minerals preclude the possibility of organic remains in them. Prof. Hawes declares that Dr. Hahn's "imagination has run wild with him." Referring to Dr. Hahn's discovery, he says: "It reminds one of the long and laborious research of a German Professor who found a whole flora and fauna, which he named with double Latin names, and which he found in his microscopic examination of basalt."

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The Microscopist.—We do not intend to occupy much more space in these columns in speaking of *The Microscopist*, but another attack full of personalities, in the December number of that paper, leads us to write a few words.

We do not usually reply to personalities of that kind, and only allude to this last article now for reasons that will be obvious.

Because we have freely criticized Prof. Stowell's paper, at first from a purely literary stand-point, and have plainly stated our opinions, the Editor complains that we have not given due regard to "journalistic courtesy." As regards that, we do not know just what the journalistic code of ethics may be, but we are fully determined that if it lies within our power to stop the free and easy, slipshod style of writing—full of slang phrases and common-place or vulgar expressions—which has crept into the microscopical literature of this country, we intend to do it; and we are not to be restrained in this, by any considerations of so-called journalistic courtesy. We can make due allowance for faults of style so long as a writer is earnest, but none for the other defects which are introduced merely for effect.

Prof. Stowell will please observe that we did not "ridicule" him for calling attention to Dr. Hahn's reputed discovery. We never ridiculed any person for an error, much less would we for calling attention to a reputed discovery. We also invite his attention to the fact that the expressions, "sensational and highly improbable," referred to the story about Mr. Darwin, not to the supposed discovery of the fossil organisms in meteorites. It is strange that he

should misunderstand such plain language.

NOTES.

—The observations of Dr. Sternberg, described last month on page 227, were made with a $\frac{1}{8}$-inch homogeneous-immersion objective, and not by a $\frac{1}{8}$-inch as there stated.

—The Report of the State Board of Health, of Michigan, for the year ending September 30th, 1880, is a valuable document. It contains much useful information for physicians and persons interested in sanitary improvements—there are some good articles on ventilation, the filtration of water, the supply of milk in cities, hygiene, and other important subjects. It is a volume of 500 pages.

—The Editors of the *Botanical Gazette*, with the coöperation of Prof. C. P. Barnes, have arranged and published a "Catalogue of the Phænogamous and Vascular Cryptogamous Plants of Indiana," which is the first nearly complete list that has been published. It can be obtained from the authors at Crawfordsville, Ind.

—Perhaps most of our readers are somewhat familiar with the recent investigations of Prof. Pringsheim, upon Chlorophyll, in the course of which he studied the action of strong sunlight upon the coloring matter, and found that the color was thus destroyed. For the prosecution of these researches a microscope was required especially adapted for studying the action of light of great intensity; such a stand was constructed by Schmidt & Hänsch, of Berlin, and is fully described in the *Zeitschrift für Instrumentenkunde*. This instrument is two or three times larger than the ordinary stands. The plane mirror is 160^{mm} in diameter; it receives light from a heliostat, and reflects it upward through a system of two plano-convex lenses 28^{mm} apart. The lower lens ha an aperture of 66^{mm}, and a focus of 93^{mm}, the upper an aperture of 48.4^{mm} and a focus of 35^{mm}. This arrangement furnishes an image of the sun 0.35^{mm} in diameter. Beneath the combination there is a support for colored fluids or glasses, when monochromatic light is required, or when the heat-rays are to be absorbed.

Above the condenser, the stage and the body of the microscope are supported on a pillar, both sliding up and down by rack and pinion movements. There is also a description of an ingenious cell for studying the effects of different gases, used by Prof. Pringsheim.

—A book on "Practical Microscopy," by Mr. George E. Davis, F. R. M. S., will soon be issued in England, and from the notice in the *Northern Microscopist*, of which Mr. Davis is Editor, we have reason to think it will be a very useful book. A fine colored plate in the November number of the *Northern Microscopist* illustrates double-stained sections of wood prepared by different processes. This plate was prepared as a frontispiece for the book.

—The *Detroit Evening News* says :—

"In a lawsuit just tried in York county, S. C., a microscopic examination was made of the defendant's hair and cuticle to determine whether she was of pure or mixed blood."

—Among the microscopic curiosities of the time, should be mentioned a working steam-engine so small that a thimble will cover it. It weighs about 15 grains, the stroke of the piston is $\frac{1}{18}$ of an inch, and three drops of water suffice for the boiler. It is composed of 140 pieces, fastened together by 52 screws. This is said to be a product of American ingenuity and skill—but we have not seen it!

MICROSCOPICAL SOCIETIES.

At a meeting of the Illinois State Microscopical Society, Prof. T. J. Burrill recounted some of his experiments with the poison of the poison-ivy. He took some of the exudation and found it teeming with bacteria, and he questioned whether the poisoning and the bacteria came from the plant or from some other source. He stated that, upon examination of the washings of the leaves, he found the same form, the milky fluid which exuded from the stem contained numbers of them; and placing some of this upon his arm, led to results of a serious nature. He went on to say that he had found the foregoing facts true with other plants, among which he mentioned the chiccory, buckwheat and dandelion.

Dr. Curtis described a new half-inch objective made by Gundlach, and owned by Dr. J. Hollist. The objective, it is claimed by the maker, has an angle 100°. The back lens of the objective is large, and extends beyond the border of the

opening in the screw. This opening, therefore, acts as a diaphragm. In order to secure the benefit of the full aperture; the back of the objective can be removed and an adapter, furnished with the Butterfield broad-gauge screw, can be substituted. It has also another screw of about the same diameter as the Butterfield screw, but provided with a finer thread. The front of the objective is ground down to a conical shape. For ordinary use, this front is covered with a brass cap, having an aperture in the centre to allow the conical end of the object to pass through. The cap can be removed when it is desired to use the objective for the examination of opaque objects. It resolves angulatum very satisfactorily, and bears eye-piecing extremely well, working admirably on anatomical structures.

Mr. E. B. Stuart exhibited a Hitchcock lamp,* which he stated commended itself to the use of microscopists. No chimney is required, it being a blast lamp, the flame of which is fanned by a current of air from the bottom. He also showed under the microscope, specimens of the gelatin-bromide plates for photographic work, that had been submitted by a photographer as imperfect. An inspection under the microscope showed three kinds of spots: one caused by particles of dust which had settled on the gelatin, while still soft, and as the emulsion hardened, became firmly fixed on the plate. The second kind of spots were apparantly caused by the solvent action of some substance on the film, as it could be seen to be less dense at those points, while the third were thicker and evidently caused by carelessly spattering the emulsion on partially dried plates.

The regular monthly meeting of the Elmira Society was held November 24th, with President Gleason in the chair, and twenty-five members and thirty-two visitors present.

Dr. Krackowizer spoke extemporaneously upon "Histological facts, where to look for them, and how to find them."

He explained cell differentiation from the simple protoplasmic unit, to the vast and complicated congregation of them in the human body. He clearly showed, by means of the black-board, the integral parts, as well as the entire woof of such tissues as the skin, mucous membrane, liver, kidney, etc., showing where their cells resembled each other, and pointing out how the observer may distinguish them.

A brief colloquial discussion of the subject followed, in which Drs. Gleason, Carr, Lucy, and the Secretary took part.

Dr. Geo. E. Blackham, made the excellent suggestion that the members of local societies should make a complete list of the microscopic organisms of this locality.

Dr. Blackham said that the meeting of the American Society, in Elmira, next August, promised to be the largest, and richest in papers, of any yet held.

* We regret that we cannot lay claim to any credit for this patent lamp.—ED.

Notices of Books.

The Galvanic Accumulator for Storing Dynamical Electricity for Cautery and Illuminating Purposes. By Louis Elsberg, A. M., M. D., etc., etc. New York: Trow's Printing and Bookbinding Company, 1881. (Pamphlet, pp. 13).

The title of this pamphlet fully describes its contents. An arrangement of the Planté secondary battery suitable for the purpose of cautery is figured and described. The article is a reprint from the *Transactions of the New York Academy of Medicine.*

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

For a packet of frustules of *Amphitetras antediluviana*, send slide, or unmounted specimen to
K. M. CUNNINGHAM,
Box 874, Mobile, Ala.

A beautiful collection of wild seeds of Central Ohio to exchange. List furnished on application.
F. O. JACOBS, Newark, Ohio.

Mounted slides of Selenites for the Polariscope, in most beautiful and brilliant colors, in exchange for first-class Histological and Pathological slides and slides of diatoms, algæ, etc.,
A. C. GOTTSCHALK,
193 North Salina Street, Syracuse, N. Y.

Unmounted objects, Foraminifera, Spicules, Plant-hairs, Zoophytes, etc., in exchange for other objects, mounted or unmounted.
E. PINCKNEY, Dixon, Ill.

Wanted—First-class mounts of double-stain vegetable preparations in exchange for first-class insect preparations.
H. S. WOODMAN,
P. O. Box 87, Brooklyn, E. D., N. Y.

Well-mounted Histological and Pathological slides in exchange for other first-class slides.
W. H. Bates, M.D., 184 Remsen St. Brooklyn, N. Y.

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The Detection of Adulteration in Food.

BY C. M. VORCE, F. R. M. S.

VI. BUTTER.

Butter was for a long time regarded as one of the very few articles that could not be successfully adulterated, as it was supposed that any adulteration would either be perceptible to taste or smell, or else would cause this very perishable product to spoil. But at the present time butter is as extensively adulterated as any other article of food. The first well-known and successful imitation of butter was the now very common oleomargarine, which, however, cannot rightly be

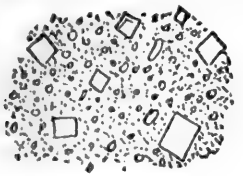

FIG. 3.—BUTTER.

called an adulteration of butter, since there is no butter in it. Still it is popularly classed, with the later product suene, as an adulterated or artificial butter, and as it competes with pure butter in the markets, and is frequently sold as pure butter, we will, for the purpose of this article, consider it among the adulterations of butter.

Pure butter, if fresh and sweet, when examined in a thin film under the microscope, is found to consist entirely of very small globules of oil suspended in a limited amount of clear fluid, chiefly water, associated with a small amount of very fine granular matter with which are occasionally found particles of coloring matter. The square crystals of common salt are always present usually in small, but sometimes in quite large crystals, as shown in fig. 3. The clear fluid of butter is saturated with salt, as may be shown by taking up a little butter on a sharp knife-blade and wiping the edge across the slide, or by using the edge of another slide as in spreading a film of blood. The extremely slight smear thus made on the glass, if examined uncovered, by a 1-inch objective, will show a crystalline structure (fig. 4), at first clear and

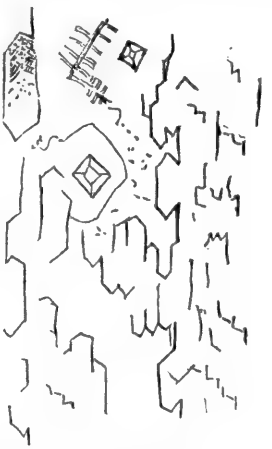

FIG. 4.—SALT-CRYSTALS.

transparent, but before long gradually becoming dendritic and opaque, at last showing feathery cystallization as the opacity spreads.

With polariscope and selenite giving a blue field, the polarizing action is faint, but when the field is darkest, a few minute, bright points wil be seen; the crystals of salt are of the color of the field but with black margins.

Only fresh butter should be examined for comparison, for butter that is old develops different crystals of salt, and becomes strongly active upon the polarized ray, owing to the formation of acids. In old butter, we find the field full of branching crystals of salt (fig. 5), and the cubes of salt instead

FIG. 5.—SALT-CRYSTALS FROM OLD BUTTER.

of being clean cut with smooth edges, are rough and jagged. With the polariscope and selenite, when the field is red, innumerable spots and blotches of bright blue, many of them of considerable size, will be seen, and extremely minute acicular, colorless crystals, with an increased amount of the granular matter present.

If any adulteration has been effected, it will be detected by its appearance, in addition to the above described characteristics. An excess of brine, or salt, is sometimes purposely added, but unless the excess of brine be considerable it is probably not a wilful adulteration, but the result of imperfect working.

The chief adulteration of butter now practised is undoubtedly the admixture of lard, producing the article called "suene," and sometimes "butterine." This product, when freshly made, is indistinguishable by taste or smell from the best pure butter, and in cold weather it keeps in this condition for a considerable time. Dealers and manufacturers claim to be able to distinguish this from pure butter by "the grain," as they call it. The tryer, when withdrawn from a tub of butter, has a "velvety feel" and a peculiar soft look, while from suene it has a "grainy feel" and look, and from oleomargarine a "waxy feel" and "greasy" appearance, they say. This difference is not readily perceptible to a tyro, but is highly probable in view of the structure revealed by the microscope in the several articles.

Under the microscope with a 1-inch objective, suene is seen to have a spotted appearance, quite different from that of pure butter; and the darker spots are balls of very fine needle-like crystals radiating from a central core, resembling miniature chestnut burs; these occur singly and in clusters, mixed with the oil-globules of the butter and with the cubical crystals of salt, and some separate needle-like crystals (fig. 6).

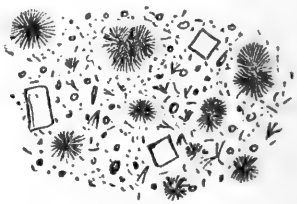

FIG. 6.—SUENE.

These balls of crystals are margarine or stearine, and represent the quantity of lard present in the sample; for pure lard is wholly composed of these crystals with a little water. The amount of aggregated and free crystals present, as found by a ¼-inch objective, therefore gives a nearly accurate measure of the amount of lard in a given sample of suene.

This adulteration is not, probably, injurious to health, but few people will relish the idea of buying lard at the price of butter; yet in all the large cities immense quantities of this suene are manufactured under various names. In Chicago about twenty factories are said to be in full operation.

Lard-crystals polarize beautifully, and the lard mixed with butter is readily seen when the polariscope is used, the balls of crystals showing a dark centre with very bright edges, and the separate needles showing brightly.

Oleomargarine, like suene, when fresh, closely resembles butter in taste

and smell. Under the microscope it also much resembles suene, but the balls of crystals seem looser and more free needle-shaped crystals are present, there is more granular matter, and there are seen fine fibres which do not polarize, which are probably fibres of connective tissue derived from the fat, and salt-crystals are present (fig. 7).

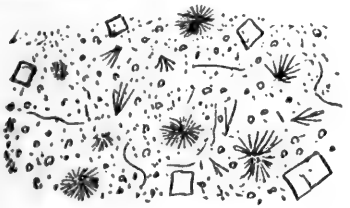

FIG. 7.—OLEOMARGARINE.

There is another adulteration attributed to the butter dealers, which is the mixture of powdered soapstone, to increase its weight. It has been charged that about six pounds of finely powdered soapstone can be mixed with fifty pounds of butter without its presence being perceptible to the taste—indeed, it is claimed that this unpalatable soapstone powder (used for foundry facings) has neither taste nor smell, and cannot be detected by the user—and direct experiment has verified the assertion. With the microscope, however, such an adulteration (being 12 per cent.) is readily detected, as the soapstone powder is coarser than the granular matter of the butter, and by melting some of the suspected butter in a test-tube and examining the sediment, if soapstone is present it will at once be detected. I have not found this adulteration myself, in butter sold by any retailer, and if practised at all, it is probably in butter packed for shipment abroad. Truly, if butter can be made half (and often two-thirds) of lard and then 12 per cent. of soapstone added, without the ordinary consumer being able to detect it, the outlook for those who are particular about their eating is not encouraging. Will the skilled adulterator succeed when he tries his practised hand on eggs?

—o—

Prof. Roger's Micrometers.

BY J. D. COX, F. R. M. S.

It is well known that Prof. William A. Rogers, of Harvard Observatory, has for some years been devoting much time, labor and money to perfecting our means for the accurate and scientific comparison and subdivision of standards of length. A machine made for him at the Waltham Watch Manufactory has been brought, under his tireless efforts, to a degree of perfection which would seem to leave very little to be desired. Results which he has reached in the ruling of micrometer plates, are so far superior to what has been heretofore done, that every one who has occasion for micrometic work must be interested in them, and the scientific world ought not to be slow in proving and recognizing the value of the improvement made.

I have a glass micrometer plate ruled by him about a year ago, containing subdivisions of the inch and the centimetre in the following form: 1st. a band of five hundred lines $\frac{1}{2500}$ inch distant from each other. These are finely but rather strongly ruled. 2d. This band is continued across the plate to the right by five hundred more lines of the same spacing, but ruled very lightly and delicately. 3d. Beneath band No. 1, is another of the same spacing ruled very lightly like No. 2. 4th. This last is continued across the plate by one ruled more strongly, like No. 1. 5th. Under No. 3 is a band of five hundred lines, one-thousandth of a centimetre apart, strongly ruled, and this is followed by a sixth, seventh and eight band in the same relation to this that Nos. 2, 3 and 4 are to No. 1 and with alternation of the strong and light ruling.

The whole plate is thus a sort of checker-board of alternating parallelograms strongly and lightly ruled, of which the upper four are subdivisions

of the inch, and the lower four subdivisions of the centimetre, there being four thousand lines ruled on the whole plate within a space four-tenths of an inch long and wide. The left-hand lines of the whole plate are made to coincide, so that a direct comparison may be made under the microscope, not only of the subdivisions of the inch with each other, but of the subdivisions of the inch with those of the centimetre. To facilitate this, the fifth and tenth lines of the inch-divisions are made longer and extend into the centimetre band a little way, so that the gain of the inch-divsions is seen in the regular way in which the fifth and tenth lines cut further into the centimetre spaces, gaining one whole division in 62½.

The first line of the fourth band of the inch divisions being continued downward as above described, is found apparently to coincide with the eighth line of the second band of the centimetre divisions (or the ninth, if the last line of the first band is counted as the first line of the second), and five hundred of the subdivisions of the inch are equal to five hundred and eight of those of the centimetres. In other terms 1 $\mu = \frac{2}{508}$-in., or the centimetre will be .3937008-in.

Since making the examination of the plate, I am informed by Professor Rogers that the comparative value of the yard and metre which he used in ruling this plate was Kater's, viz. : 39 .37079. This is the same as the ratio given by Beale ("How to Work with the Microscope") as the English statutory relation. Prof. Rogers has since ruled other plates with the Chisholm ratio, viz. : 39.37112, and is working upon an independent comparison of the English and French official standards.

Taking the Kater ratio which the professor used in making the plate, it will be found by computation that if we divide .2-inch by 507.995 we shall get the centimetre value .3937046; and if we divide the .2-inch by the Kater ratio, 3937079 we shall get the number of spaces 507 990+. It is thus shown that the apparent equality upon the plate of 508 of the centimetre spaces with 500 of the inch-divisions, cannot be out of the way by one-hundredth of one of the divisions; but as these divisions are $\frac{1}{2500}$ inch, the maximum difference is one two-hundred and fifty-thousandth of an inch. As the space between the striæ of a fine *Amphipleura pellucida* is a hundred-thousandth of an inch, and the 19th band of Nobert's plates is but little closer, it needs no further proof that the apparent coincidence of the lines described above cannot be distinguished from complete coincidence by any objectives made, and we are unable to prove that Prof. Rogers has not exactly transferred to the plate the ratio between the centimetre and the inch.

Let us now take a general view of the plate itself. If we begin at one end of the bands in juxtaposition and go carefully through it, we cannot fail to be struck with the great evenness of the gain of the inch-divisions upon those of the centimetre. The more accustomed one is to the comparison of micrometer divisions, the more lively will be his surprise and pleasure at finding that in all these five hundred spaces thus compared there is no visible mark of inequality. I have never seen any other ruling which would stand even this test of the direct comparison of such bands of striæ ruled at different times and by a different, though related, scale.

But, of course, the final and only strict test for the microscopist is the actual measurement of the spaces by means of camera, of eye-piece micrometer, or by photography. By means of the Jackson eye-piece micrometer I have made a comparison of this plate with two stage-micrometers of standard European make. Of these one is known by a series of experiments made in the Coast Survey Office, to be made with a screw giv-

ing the divisions about two per cent. too large, but the divisions are exceptionally even, as micrometer ruling goes. The other has the average length of the divisions nearly accurate, but they are of inferior evenness.

The power used in examining them was about 450 diameters, as the coarseness of the lines in the ordinary micrometers was such that with greater magnification the liability to error in judging when the hair-line of the eye-piece was in the middle of the stage-micrometer line was more than an offset to the advantages. With Prof. Rogers' plate a higher power could be made useful, because the lines themselves are finer.

The following is the result of a series of average evenness of results out of a number made with each micrometer.

Hundredths of an inch—Plate No. 1.

Space—	1	2	3	4	5	6	7	8	9
Measure—	45	44.8	45.2	45.4	45.1	45	45.2	45.4	45.1
10	11	12	13	14	15	16	17	18	19	20
45	45.3	45.5	45	45	45.2	45.4	45.2	45	45.1	45.5

Plate No. 2.

1	2	3	4	5	6	7	8	9	10
46	45.7	45.7	46	45.7	45.6	46	45.8	46	45.6

Rogers' Plate.—The measurements were 45 throughout twenty spaces with no appreciable variation. This was the more striking, because as the ruling was to $\frac{1}{2500}$-inch, the alternate five and ten space long lines were necessarily the boundaries of hundredths, and there was no special ruling of hundredth spaces on the plate.

Thousandths of an inch—Plate No. 1.

1	2	3	4	5	6	7	8	9	10
4.5	4.5	4.6	4.5	4.5	4.5	4.6	4.5	4.6	4.6

Plate No. 2.

1	2	3	4	5	6	7	8	9	10
4.6	4.5	4.5	4.6	4.7	4.75	4.6	4.7	4.6	4.6

Rogers' Plate.—As there were no spaces of .001-inch first, I took the least number of spaces that would make even divisions of the eye-piece micrometer. As the test was only for evenness, and not for absolute measurement, I was not careful to take the identical magnification, and shortened the tube to accommodate more readily the divisions of the eye-piece to those on the stage. I thus made twenty divisions of the ocular, equivalent to seven of the plate. Twenty successive tests of this measure applied to twenty different groups of seven spaces each, showed no variation whatever. The value of the thousandth was thus made, .357 throughout.

Next, I examined separately twenty single spaces, each $\frac{1}{2500}$-inch, with a higher power (one-tenth objective). These were taken at irregular intervals across the plate, and brought successively to the same line in the eye-piece, the tube being adjusted till the first was as exactly as possible equal to six spaces in the ocular. The plate stood the last test quite as well as before, each division precisely filling the measure applied to it, and being magnified 750 times.

Of course it would not do to say that there are absolutely no inequalities in the spacing, but only that were none measurable by the means employed, and that by whatever means the divisions were measured, their regularity and equality were something unparalleled in my experience.

It is true also that the above gives no test of the absolute accord of the divisions with the standard inch or centimetre. For that we must trust Prof. Rogers' methods till some very elaborate tests can be applied. But it certainly shows both that the relation of the fractional inch to the centimetre is exactly reproduced in the plate, and that the subdivisions are equal to each other within inappreciable limits.

In the measurements I was of course careful to use always the same subdivisions of the eye-piece micrometer, so that no errors in its ruling might mingle with the results. Similar tests applied to a plate ruled more recently by Prof. Rogers produced similar results, showing that the acccuracy of the first is not exceptional, but is only a fair sample of the ruling the Professor is able to do with his new machine.

Immersion Fluids.

[Dr. Henri Van Heurck has communicated to the "Société Belge de Microscopie" an article on the formulæ of new liquids for homogeneous-immersion objectives, the following summary of which has been prepared from the *Bulletin des Séances.* —Ed.]

Personally, we have been able to appreciate, perhaps better than others, the importance of homogeneous-immersion objectives, for it is by their use that the numerous drawings of the *Synopsis des diatomées de Belgique* have been completed in a relatively short time. When we think of the trouble which the employment of monochromatic light occasions, of the frequent interruptions of work necessitated by the absence of sunlight, we cannot sufficiently congratulate ourselves because of this happy discovery, which has enabled us to advance the publication of our work, perhaps by several years, of which all the drawings, both Mr. Grunow's and our own, have been made with the aid of objectives of this new system.

At first homogeneous-immersion objectives were constructed without collar-adjustment. Is this well? At one time we believed so, but after having used for a short time a $\frac{1}{10}$ homogeneous-immersion, by Tolles, with adjustment, we have changed our opinion, and found that the correction renders great service in certain cases; for example, when the objective is to be used on microscopes having tubes of different lengths, which is sometimes necessary, as in the case when one has to make drawings of a definite magnification, and also when the index of refraction of the immersion fluid slightly changes by extremes of heat or cold, or from other causes.

The oil of cedar, proposed as the best immersion fluid, has the disadvantage to dissolve the varnish, and its fluidity makes it inconvenient to use.

Prof. Abbe has examined 300 substances without finding one better than oil of cedar. The researches recorded here were conducted by the aid of Prof. Abbe's refractometre, and have finally been crowned with success; since we now know a considerable number of substances which may be advantageously employed. The necessary conditions are:—

1. A suitable index of refraction. This index, for objectives now made, is about 1.510. The crown-glass, of which the cover-glass and the front lenses of the objectives are made, has an index from 1.510 to 1.520, measured by the *F* line of the spectrum.

2. A dispersive power near as possible to that of crown, which is about .0060 measured between the lines *D* and *F*.

3. It must not be excessively fluid.

4. It must not attack the varnish of the cells.

In this note we give the results of our researches, but first we pass in review the liquids heretofore proposed.

These liquids may be divided into two classes:—

1. Solutions of chemical products.

2. Vegetable substances.

All the substances proposed up to the present time are solutions of salts in glycerin. The best of these liquids is Bassett's fluid, which is prepared by dissolving crystals of chloral hydrate in glycerin. The principle inconvenience of Bassett's fluid is its action upon the varnish and especially shellac. This liquid has been almost discarded. The other solutions are:—

Cadmium chloride in glycerin; index 1.504.

Zincic iodide in glycerin; index 1.507. dispersion 0.0080.

Zinc sulphocarbolate in glycerin; index 1.500.

Finally, distilled zincic chloride has been proposed, but this is a difficult substance to manage.

Among the vegetable substances proposed up to the present time we have:—

Oil of cedar, formed by the distilla-

tion of *Juniperis Virginiana*. It has an index of refraction varying from 1.505 to 1.507. Its dispersion is 0.0073. It has been lately attempted to overcome the objection to the essence of cedar, its excessive fluidity, by dissolving in it some damar, which at the same time permits its index of refraction to be raised to 1.520.*

Essence of copaiba has the same index of refraction as the oil of cedar, and is somewhat less fluid. It is, therefore, an excellent substitute for the latter. This essence is not furnished by the true copaiba, but comes from the distillation of Indian copaiba, yielded by different species of *Diptrocarpus*.

Our first researches were directed among the chemical substances, but they led to no important results. We then turned our attention to the natural, vegetable products, and the result has been favorable. The oleo-resins, the resins and the gum-resins of the Terebinthacæ, having yielded the best results.

The balsam of copaiba, already mentioned, has an index of 1.509. It is, therefore, preferable, owing to its viscosity and its higher index, to the essence of the same product. The gum-resin olibanum (yielded by several *Boswellia* of eastern Africa), commonly named incense, partly dissolves in essence of cedar, giving a quite a thick liquid, of which the index of refraction is 1.510 and the dispersive power is 0.0677.

To prepare this liquid the pure drops of olibanum are finely pulverized, and the powder obtained mixed with an equal volume of oil of cedar and heated on a water-bath for two or three hours. Allow the liquid to stand, and when clear decant the supernatent fluid.

The resin of Manilla, the botanical origin of which is uncertain, dissolves readily in oil of cedar, and thus furnishes liquids of which, according to the proportions of the substances employed, the index may be made to rise from 1.510 to 1.520, with a dispersive power of 0.0076. By adding castor oil to the solution a suitable liquid is obtained, having an index of 1.508 and a dispersive power of 0.0073. But this solution seems to us less useful than the solution of olibanum, because it is slightly sticky.

The resin of Brazil,* and the white, oily tacamaque of Guibourt give equally good solutions with oil of cedar. By dissolving the tacamaque in the oil, a liquid having an index of 1.519 and a dispersive power of 0.0074 is obtained. By adding to the solution castor oil in suitable quantity, the index descends to 1.508 and the dispersion to 0.0072.

To prepare the solution, dissolve, on a water bath, 20 parts by weight of the resin in 22 parts of the oil of cedar, and add 14 parts of castor oil. According to Prof. Abbe, this solution, and that of damar in oil of cedar, are the best ones known for homogeneous-immersion objectives.

An authentic specimen of Chinese varnish, but already possessing sap of *Rhus verni*, L., brought from China by Perrottet, has an index of 1.527. This oleo-resin mixes perfectly with the essence of cedar, giving solutions which may be employed. The turpentine of Scio is furnished by the *Pistacia terebinthus*. We have found 1.535 as the index of refraction of a sample of old and pasty resin, from the collection of Guibourt. It dissolves in oil of cedar and may give a liquid of the desired index.

Copaiba is furnished by *Copaifera officinalis*, L. That found in commerce at Antwerp, and which appears to be the true copaiba of Maracaibo, is of a clear brown color, and has an index of 1.519, and an authentic specimen, from Guibourt, of copaiba of Para has only an index of

* Prof. Abbe has lately mentioned an excellent liquid, which is obtained by dissolving damar in oil of cedar until an index of 1.520 is obtained and which can be brought back to 1.509 by an addition of castor oil.

* Resin of *Fagara octandra*.

1.506. Copaiba dissolves perfectly in oil of cedar, and gives a liquid of the index desired. Another liquid is also obtained of an index of 1.510 and of a dispersive power 0.0076, by dissolving with heat 7 parts of white vaseline in 30 parts of copaiba. One thus obtains a very thick liquid remaining where it is placed and not acting upon asphalt nor shellac varnish in twenty-four hours' contact. If this liquid is too thick it may be thinned by adding a quantity of the solution of copaiba in oil of cedar. This liquid gives good images with axial illumination, and shows perfectly the most minute details of diatoms with oblique light.

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The Phenomena of Growth among the Microscopic Forms of Life.*

I do not come before you this evening to discuss any of the problems which lead us beyond the pale of direct observation into the realms of speculative thought. Although our subject carries us to the dim borderland of life—where it is not only impossible to distinguish plants from animals, but where even the transition from the inanimate to the living, the inorganic to the organic, is imperceptible,—yet I will not ask you to follow me in any presumptuous efforts to bridge, even in imagination, the narrow chasm which separates the one from the other. It will suffice for our purpose to know that the smallest particle of matter that the microscope can reveal,—and others even too small to be defined by the best microscopes known, smaller than the length of an undulation of light, may possess all the attributes of life. We know that such particles live because they move and grow and multiply. They possess, therefore, a certain organization which distinguishes them from non-living matter. However, the use of the word organization, in this connection, has occasionally given rise to misconceptions, for none of the simplest forms of life are organized in the sense of having muscles, nerves, vessels, or any differentiation of parts for special functions. Thus, we may find a simple spherical mass of jelly, absolutely without a trace of visible structure, manifesting all the phenomena of life. Therefore, organization, in this sense, does not mean visible structure, but it relates to the arrangement of the atoms and molecules which compose the living matter.

A brief reference to the minute animal known as the amœba will serve as an introduction to the subject before us. The amœba consists principally of a transparent, clear, or granular mass of irregular shape, ranging in size from $\frac{1}{70}$ down to $\frac{1}{3000}$ of an inch, or even smaller, resembling jelly, which is known as bioplasm, or protoplasm—the physical basis of life. Within the protoplasmic mass a more dense, circular structure is sometimes found, which is termed the nucleus, the special function of which is still a matter of investigation. The external layer of the protoplasm is somewhat more dense than the rest, but it does not constitute a distinct membrane or cell-wall, such as we find in more highly developed organisms.

If we conceive of the amœba enclosed within a membrane giving a spherical shape to the organism, we have the idea of a true cell, which is regarded as the life-unit in both the great kingdoms. It is by the assimilative powers of cells that growth takes place, and by their division all structural development proceeds. A typical cell consists of protoplasm and nucleus within a membrane known as the cell-wall. However, the life of the cell resides in the bioplasm. It is the semi-fluid contents and the nucleus of the cell that lives —all the rest is dead matter. It seems absurd then, to regard the

* Address of the retiring President of the New York Microscopical Society, delivered at the Annual Reception, Friday evening, February 3d, 1882.

limiting membrane, the cell-wall, as an essential element in the ultimate life-unit. Even in cell-multiplication by the ordinary process of division, the wall takes no part, for within the parent cell it is the protoplasm that divides into two or more parts, beginning with the nucleus. A constriction forms in a certain plane, and new cell-walls are secreted by the two masses of living matter. As the cells increase in size the original membrane must give way or disappear. But it may still be said that the physiological unit of life is the cell; for, although naked bioplasm may live, assimilate food and grow, no differentiation of parts can result until there is some product, a secretion, a cell-wall or limiting membrane, to give form and structure to the primal elements of growth.

The living jelly, so readily studied in the amœba, seems to be identical with the protoplasm of every animal and plant from the highest and most complex down to the lowest and simplest.

Let us, therefore, examine this protoplasm more carefully. As the amœba moves, one portion of the body is projected forward, and the less dense protoplasm within begins to flow in the direction of the projection, like so much water, carrying with it the spherical granules which are usually abundant in the body.

The amœba has no mouth, but when a digestible morsel is found the body simply flows around and envelopes it, and the process of assimilation immediately begins; the indigestible portions are allowed to escape from any part of the surface of the body. Hence, it appears that protoplasm has the power of assimilating solid food and converting it into living matter, which is the process of growth. When the amœba attains a certain size, a constriction forms across the body, or gradually deepens until the animal becomes divided into two parts, which finally separate and move away as independent individuals.

This simple process of propagation is typical of what takes place throughout the living world. Among the simplest forms of life it serves for the multiplication of individuals, but as we ascend the scale the process of reproduction becomes more complex, and division of the constituent cells becomes a process of growth rather than of reproduction. We may, indeed, regard the human body as an assemblage of units, each of which multiplies by division, like the simple amœba, and thus contributes to the repair of waste in the tissues. The process begins in the germinal cell, and by its continuance the complex organs of the body are evolved, according to some inscrutable law. The reproductive process of the amœba, therefore, typifies the growth of higher organisms; for the first considerable advance in structural evolution is in the production of a more complex organism by the division of cells, the progeny of which, instead of separating from the parent-cells as new individuals, remain as integral and interdependent parts of one organism, each cell, or group of cells, having specific functions in the economy of the animal or plant.

Among the green, confervoid algæ of ponds and ditches are found many plants which consist of a series of cells attached end to end, forming filaments. These plants are termed multicellular, to distinguish them from the unicellular species, and they are classed higher in the scale of organization. But complexity of structure, as thus manifested, is not, so far as my judgement permits me to observe, an indication of a higher stage of cell-life; for each cell of the filaments is complete and independent of all the others. There is no physiological bond connecting them, as in the higher plants, but each one carries on an independent existence, and is not killed if its fellows are destroyed. Between the filamentous plants and the strictly unicellular forms which consist of spherical, green cells, living

separately, we find a succession of intermediate forms in which the cells are bound together by a more or less firm mucous, or gelatinous substance, some in layers of indefinite extent and arrangement, others in well-defined families. But however they may be related, each cell, so far at least as its merely vegetative functions are concerned, is quite independent of the others, for it possesses within itself all the powers necessary for its existence as a living organism. In other words, these plants belong to such a low stage of life, that there is no distinction between the cells, such as we find in higher plants where certain cells contribute to the formation of tissues, others convey the nutrient sap, and still others produce the organs of reproduction, the pistil and stamens. It follows that in such low plants we must look for all the phenomena of growth and reproduction in each cell —each cell is, in fact, a perfect plant. Hence, no classification of these plants based upon their manner of growth, can be regarded as quite satisfactory to the scientific student. The tendency now is to base all classification upon the methods of reproduction, which, being the ultimate process in the life of every organism, characterize its mature stage and indicate the point at which its development was arrested in the course of its evolution.

Complication of structure results from cell-division, but it is necessary to observe that all cases of cell-division do not lead to structural complexity; for in the case of strictly unicellular protophytes or protozoa, the production of new cells or gemmæ, within the parent, leads to what seems to be a multicellular stage. But each new cell produced under such circumstances is, physiologically and anatomically, an independent individual, in no wise dependent upon the others for support, but capable of separate existence. Hence, the multicellular condition, when it thus occurs among the strictly unicellular organisms, is in no wise a higher condition of organization, but only a temporary phase brought about for a special end. It is only when the multiplication of cells is a phenomenon of growth and the resulting cells form constituent parts of the organism, that there is any advance in structure. This is the case in an ovum which, by repeated cell-division, produces a morula.

Carrying the ideas embodied in this view one step further, it should also be observed that while the cell, in a physiological sense, can be justly regarded as the typical unit from which all living forms are derived, as taught by the generally accepted cell-doctrine, yet the student of the lower forms of life cannot fail to observe that all the structures to be found in protophytes or protozoa, as well as many found in the higher planes of existence, do not result from cell-division—that many of the appendages such as carapaces, flagella, cilia peduncles, etc., result from processes of growth, or secretion, without cell-division.

The dictum that has so long been taught by physiologists that all structures originate in cells, cannot longer stand.

The most complex cell is a ciliated infusorian, and in these animals there are many structures which must be regarded as true secretions of the cell, not produced by cell-division, as usually taught.

Sometimes on an old decaying log by a brook along the road, or half buried in forest soil where it is always moist, there will be found masses of a soft, jelly-like substance. This, when examined with a microscope, may be seen to move. It is a mass of living jelly. Is it an animal or a plant? This question has puzzled the microscopists for years, and even now they are not all agreed as to the affinities of the myxomycetes, as they are called. Saville Kent, one of Eng-

land's most eminent authors, believes in their animal nature, but they are usually claimed by the botanists, and it is not unlikely that they will yet be identified as a stage in the life-history of certain fungi. But the mere fact that there is still ground for a difference of opinion regarding their animal or vegetal nature proves that the two kingdoms run very close together. A manifestation of plant-life that has been the source of much confusion is the motile stage, which comes into the life-history of many of the algæ, serving as a means of propagation. The contents of certain cells become changed into one or more swarm-spores as they are called, which consist of minute, green, spherical or oval, protoplasmic masses provided with one or more hair-like appendages which, lashing constantly in the water, cause the organisms to swim about. One morning I sat down to examine, with the microscope, some algæ from a collection of the previous day. Among them I found some long, cylindrical filaments composed of a series of short cells, about as long as broad, joined end to end, and filled with bright-green contents. In some of these filaments the green contents of each cell had collected into a ball which was moving restlessly. In a few moments the membrane that confined them ruptured on the side, and allowed the moving masses to escape. One by one, in rapid succession, the little balls, only about $\frac{1}{5000}$ in diameter, were set free, and they moved away rapidly. They were the swarm-spores of the plant *Ulothrix*, and upon close inspection each one was seen to be provided with two very slender filaments springing from one end of the slightly elongated mass, two or three times longer than the body, and so fine that they only became visible when greatly magnified and carefully illuminated. By the constant lashing of these delicate appendages the swarm-spores moved about in the water.

This process of propagation is quite common among the cryptogamic plants. After the swarm-spores are set free, they swim about for a short time, then become attached to something and begin to vegetate, forming a new plant like the parent. I remember watching, for the greater part of a night, the formation of swarm-spores in the cells of the beautiful *Spirogyra*, an alga which is very common in the early spring in roadside ditches and ponds. A large number formed in each cell of the *Spirogyra*, and for a considerable time moved about in their confinement very actively. At last an opening formed in the cell-well through which the active spores slowly made their way, just as an India-rubber ball might be forced through an opening smaller than its diameter. Once free they were soon lost sight of.

These swarm-spores are simply masses of protoplasm, colored green by chlorophyll, the coloring matter of the vegetable kingdom, which have a scarcely perceptible enveloping membrane, with the two or more hair-like, lashing filaments. They do not assimilate food, but pass an ephemeral existence swimming through the water, finally becoming attached to something when they begin to grow into new plants. They serve to propagate the species of the plants from which they spring. Yet, although so utterly devoid of organization, they are sensitive to the influence of light, and in the mother-cell they seem to mature at certain hours of the day, which vary with different species. Place the algæ in a shallow dish, and the spores will be set free in a greenish cloud which slowly makes its way toward the window, and finally forms a green border around the dish on the side nearest the light.

In these processes we have seen no indication of any distinction between the different cells, such as would lead to the inference that one is a male-cell and the other a female. But the homology of nature seems to require that there should be such a distinction some

time in the life-history of even the simplest plants; for only by the union of opposite elements can the vegetative life be maintained. We can hardly suppose that a single cell could give rise to an unlimited progeny by division continued indefinitely. The vitality of the later generations would finally be exhausted, and the species could then only be maintained by some kind of sexual union which renews and vivifies. But while we say this, it should be understood that the characteristics of the male and female elements of plants and animals are not known. Conjugation signifies the union of these two elements, but in the lowest stages of life no difference can be distinguished between them. It is even doubtful if they possess any distinguishing characters, for when any two particles of protoplasm come together and coalesce, we call it true conjugation; and the living contents of a single cell may separate into two parts, one part passing to one end and the rest to the other end of the cell, after which the two portions may again unite and form a spore.

Passing a step higher in the scale, we find many plants that conjugate by the union of the cells of two filaments and the intermingling of their protoplasm results in the formation of a spore, from which new plants develop. This is the case with all the family Zygnemaceæ, the fruit of which is called a zygospore. As an example of this interesting process, we may choose a species of *Spirogyra*, a filamentous alga common in our roadside ditches, which has received its name from the spiral arrangement of the coloring matter within the cells. When the time of conjugation arrives, the cell-contents lose their regular arrangement, and finally two filaments, lying side by side, will send out short extensions which gradually approach each other, unite by their ends, after which, by the dissolution of the terminal partition, there will soon be formed tubular passages from the cells of one filament to those of the other, and the two plants will be united as by the rounds of a ladder. Then all the protoplasm of the cells of one filament flows into the cells of the other and there forms a spherical mass, enclosed within a rather thick wall, called the zygospore. The original cell-walls then decay, the spores ripen and from each of them a new plant like the parent form will spring. Watching them under the microscope from day to day, spiral bands will be seen forming in the interior green mass. In due time the outer covering breaks, and the young plants appear as oval cells with bright-green spiral bands of chlorophyll, which slowly elongate, divide and produce new filaments.

We have no time this evening to indicate the important role which the most minute living creatures play in the world ; but, owing to the interest now taken in sanitary questions, it seems advisable to briefly refer to those minute plants known as bacteria, which are supposed to be the active agents in the production and spread of contagious diseases.

It has been found that in the blood of men and animals suffering from certain disorders, of a more or less fatal and contagious character, there are numerous rod-like or spherical particles, which are the bacteria. By cultivating these organisms in suitable fluids, such as milk, extract of meat, chicken broth, etc., they can be made to propagate rapidly, and the progeny, after many generations, will still possess the power of producing the disease when introduced into the blood of a healthy animal. But it has also been discovered that by cultivating the same virulent bacteria in a certain way, they can be so changed in their action upon the system that they will no longer produce the disease in its original severity, but give rise, by inoculation, to a modified form of the same disease which is mild, not in the

least dangerous, and only local in its external manifestations. Yet this milder form of the disease is a protection against the more malignant type. Upon this fact depends the efficiency of vaccination. The disease produced by vaccination is a mild form of small-pox. The results of recent investigations leave no reasonable doubt of the protective influence of vaccination, and, while there are always a few headstrong and conservative individuals in every profession, it is not strange that there should still be a very limited number of physicians who oppose vaccination as a useless proceeding. But there are not two sides to this question, and it must be the opinion of every person who will study the subject with care, that the welfare of the community requires that vaccination should be made compulsory.

Upon every leaf and flower, in the air and in the water, from the regions of eternal snow down to the bottom of the deepest seas, the simplest forms of life are found. Among these, wherever they may be, the struggle for existence is incessant, and one has only to make use of a microscope to see the fight in progress—battles which, in miniature, portray the greater conquests of beasts and men which have resulted in the present condition of development.

Within the microcosm of a single drop of stagnant water, may be found myriads of living forms of curious shapes and strange habits, all manifesting the powers of growth and reproduction in the simplest form. Higher in the scale the processes of life become more complex, gradually, as development proceeds, we see a differentiation of the cellular structures, so that cells subserving special purposes become distinct from the others, and this distinction becomes more and more defined as we go still higher, until finally the specialization of function results in the perfection of each organ for its work, and in the mutual interdependence of the parts which constitute the perfect whole. It is this specialization and adaptation that marks the essential distinction between the simple and the complex forms of life. It is a striking thought that all the functions of the human body have their counterpart in the structureless amœba. Yet it is more than a suggestion of fancy, since biology teaches that the development of all forms is a result of the division and the gradual differentiation of simple cells. The changes in the forms of animals, which have been gradually brought about in the struggle for existence, the adaptation to surrounding circumstances and the survival of those best fitted to withstand the conditions about them, have progressed through unnumbered centuries, until the existing forms of life have become what we find them. As the geologist reads the story of the world's long history on the leaves of solid rock, and there finds the record of its gradual evolution, through sudden catastrophes or the more slow and steady action of other influences still at work, wearing down the mountains and filling seas and valleys, so the embryologist can trace the results of the environments of centuries in the animals of to-day. For all the changes of form which have resulted in the perfect animal as it has slowly developed and been modified by external conditions, have left their records upon the germ, so that all the great features of its past history are revealed in the course of its embryological development. The modifications which were only brought about through the changes of the geologic ages, are again passed through in embryonic life, in the course of hours or days. This potency of life must first be latent in the microscopic germ—the single cell from which all living creatures spring—and while in the beginning these seem to be all alike, while many of them proceed in parallel lines as they develop, yet each one with a strange certainty, reproduces its parent form.

The biologist no longer directs his efforts to the discovery of the essential nature of life. He may indulge in fruitless speculations, which, as in the most distant past, still possess a fascination, and lend an undefinable charm to the imagination when it is free to overstep the bounds of finite knowledge and conjure up strange fancies of those mysteries which only an infinite mind can comprehend. But in his investigations he recognizes a limit beyond which he cannot go. His ultimate aim is not to discover life itself, but to learn as much as possible of its manifestations, and to this end he must become familiar with the primal forms of living matter from which have grown the living world as we see it now.

The life-force endows matter with potentiality to pass through a definite series of changes until a certain result is attained, beginning with the simplest germ and producing as its highest result, the means of its own renewal through successive generations.

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On the Relationship of Æcidium Berberidis, Pers., to Puccinia Graminis, Pers.*

BY CHARLES B. PLOWRIGHT.

There are not many more important questions in the whole range of vegetable physiology, than those connected with the *Entwickelungsgeschichte* of the fungus which causes the mildew in wheat. The magnitude of the issues at stake have been forcibly brought before us who reside in the large corn growing country of Norfolk, during the last few weeks, where acres of wheat which, within a month or three weeks of harvest gave promise of an abundant yield, were in less than a fortnight blighted to such an extent that in some instances considerably less than half a crop only was produced.

In the month of May of the present year (1881), I performed some experiments with the view of convincing myself one way or the other upon the connection said to exist between *Æcidium berberidis* and *Puccinia graminis;* but owing to my non-acquaintance with the proper method of performing them, they resulted in failure. I then wrote to my esteemed friend, M. Max Cornu, who immediately, in the most kind manner, gave me full and explicit directions as to the proper mode of procedure. On the 18th June I commenced a second series of experiments, which have been continuously carried on until the end of September, in which one hundred and seventy-six plants of wheat have been employed. I propose laying before you a detailed account of each experiment, in order that you may be enabled to form your own opinion as to their results. But before doing this, I may be allowed to say that they were commenced and conducted, as far as it is possible to do so in such cases, with my mind unbiassed one way or the other, either for or against the theory of heterœcism. For upon the one hand I had a feeling that this theory was, to say the least, very remarkable; while upon the other, there was the fact of its acceptance, almost without question, by the majority of continental mycologists, by men whose acumen is undoubted, and who justly rank in the fore front of scientific botany. My mind was in a state of "expectant attention," but I had no other feeling in the matter, having never committed myself to an opinion either *pro* or *con.*

Before detailing these experiments, there are some circumstances that have certain weight, both for and against, which should be fairly stated in order that a more just opinion may be formed than would otherwise be the case. In the first place it may be thought that the connection, as different states of the same fungus, between an *Æcidium* and a *Puccinia* is too wonderful to be true. We may

* Abstract from the paper as published in full in *Grevillea.*

readily enough accept the numerous other instances of polymorphism afforded by the fungus kingdom, and yet be unable to credit that a parasitic fungus can commence its life on one plant and finish it upon another, especially when the host plants are so far removed from one another, that the one is an exogen and the other an endogen. But this alternation of generation is well known to exist in other departments of the organic world, amongst organisms far higher in the animate scale than cryptogams. To take a well-known example afforded by the *Entozoa*, the *Tenia mediocanellata*, Küch, commences its existence in the flesh of the ox, as *Cysticercus bovis*, and finishes it in the alimentary canal of man; or *Tenia solium*, Linn., which commences its existence as *Cysticercus celluosæ* in the flesh of the pig, and finishes it in the same situation as the first mentioned cestode.

There exists a widely spread superstition amongst agriculturists, which was credited far more extensively by the past generation of farmers than it is now, that the presence of a barberry bush was connected with the occurrence of mildew in wheat. So much was this the case that in most parts of Norfolk the barberry (*Berberis vulgaris*) has, to a great extent, been exterminated. Now, nothing tends more to render a statement incredulous to people in general and to scientific minds in particular, than to brand it with the title of superstition. We dislike above all things to be thought superstitious, it is derogatory to our intellectual status. Without entering upon the question generally, of whether most superstitions have not a strain, however meagre, of truth underlying them, this sentiment has not been without considerable influence in rendering us chary of accepting the heterœcism of *Puccinia graminis*. It must, however, be borne in mind that the connection of barberry bushes with mildewed wheat presumably arose, as a matter of observation on the part of our forefathers, when they suffered from the pest.

Leaving the sesubsidiary considerations, and for the moment discarding the element of heterœcism, let us consider whether there be any impossibility in the *Æciaia* generally being the earlies states of certain *Puccinieæ*. It is presumed that no one now doubts the connection of the majority of *Uredines* with *Puccinieæ*, and it must be borne in mind that a much greater difference existed in form, color and spore structure between *Puccinia* and *Uredo* than is the case with *Æcidium* and *Uredo*. The free spores of many species of *Æcidium* cannot be distinguished from the spores of many *Uredines*. *Æcidium* as a genus differs from the *Uredo* principally in the possession of spermogonia, of a peridium, but more particularly in producing its spores in chaplets. All *Æcidia*, however, do not possess spermatia, for of the thirty-two species enumerated as British in the "Handbook," the presence of spermogonia is only noted in four; while certain *Urdines* are provided with them, *e. g.*, *U. suaveolens*, Pers., *U. orchidis*, Mart., *U. gyrosa*, Rebent, *U. mercurialis*, Link., *U. Euonymi*, Mart., and *U. pinguis*, D. C.

Sir John Lubbock, in his address to the British Association at York, last August, has very pertinently said, "Naturalists are now generally agreed that embryological characters are of high value in classification," the truth of which assertion is daily becoming more and more accepted by students of Natural History.

Now when we cause the spores of *Æcidia* to germinate under circumstances in which we can watch the process, we find they do so in exactly the same manner as *Uredo* spores, namely, by the protrusion of a hyaline tube through the epispore. This hyaline tube gradually elongates, and into it are emptied the contents of the spore, which are passed onwards until they eventually reach the end of the tube. This tube (or tubes, for there may be more than one) undergoes in both in-

stances the same spiral movements, and, unlike the tube produced by the germinating *Puccinia* spore, it does not, as a rule, produce secondary spores.

The association of *Æcidium* with *Uredo* (in some state or other, either as *Uredo*, *Puccinia*, *Uromyces*, or *Coleosporium*) upon the same plant, often upon the same individual, and even upon the same leaf, is a fact well-known to practical mycologists.

Of the thirty-two species of *Æcidium* enumerated in "Cooke's Handbook of British Fungi," this association exists in twenty species. In some cases we find in nature this exists very closely, *e. g.*, *Æc. ranunculacearum*, D. C., and *Uromyces ficariæ*, Lev., *Æc., epilobii*, D. C., and *Puc. epilobii*, D. C. *Æc. compositarum*, Mart., and *Puc. compositarum*, Sch., are often found upon the same leaf; while *Puc. sparsa*, Cooke, is expressly said by Dr. Cooke to be "only found amongst or near the oxolete pustules of *Æcidium tragopogonis*, Pers.

There is, however, a much wider question broached when we come to associate the *Æcidium*, known only to exist upon an exogenous plant with a *Puccinia* confined to endogenous plants. In order to convince reasonable minds, the evidence must be unimpeachable and complete. No mere coincidences, however numerous, can *per se* be taken as conclusive."

[A series of experiments is then detailed in the original article, which occupy too much space to be reprinted here. As an indication of the manner of experimenting, however, the first one is given in full.—Ed.]

Experiment I. — On 18th June, 1881, seven healthy young wheat plants, about six inches in height, were infected with the spores of *Æcidium berberidis*, which were mixed with water, and freely applied to both surfaces of the leaves, and particularly to the angle which the blade forms with the stem. The pots containing the infected plants were covered by a large bell glass, and plunged, with great care, into the ground. At the same time, eighteen precisely similar wheat plants, grown from the same seed, were placed in the ground in a pot, and covered by a bell glass, to be kept as check plants. The *Æcidium* was obtained from North Wooton, distanced three and a half miles, and the spores were used for inoculation within two hours from the time they were gathered. A number of them were at the same time placed upon a drop of water on a glass slide, and kept in a damp atmosphere, for forty-eight hours, when they were found to have germinated freely, which was proof positive of their vitality, and that they had not been injured by removal. Both groups of plants were watered from time to time, which was done by raising the edge of the bell glass covering them, an inch or two. At the end of ten days the bell glasses were removed, and the plants examined daily. On the twenty-fifth day a single spot of *Uredo* was observed upon one of the infected plants; the others all remaining free. On the thirtieth day this leaf was removed and examined, and found to be veritable *Uredo linearis*. On the thirty-second day two more of the infected plants had *Uredo* upon them, but it was now found upon the check plants: that is, in twenty-two days from the time they were uncovered. On the forty-third day the experiment was concluded, when the whole seven of the infected plants had *Uredo* upon them, as well as sixteen out of the eighteen check plants.

The result of these thirteen experiments may be thus summarized:

Seventy-eight wheat plants were infected with the spores of *Æcidium berberidis* and ninety-eight similar wheat plants kept as check plants against them. Of the infected plants seventy-six per cent. developed *Uredo* in an average of 24.4 days. While in the same period seventy per cent. of the uninfected plants became spontaneously attacked by *Uredo*. One

experiment only (No. 2), out of the thirteen was wholly in favor of the theory, and that lasted only twenty-three days. Still six per cent. more of the infected plants took the *Uredo* than of the uninfected. This is a very small portion, far too small in my humble opinion to constitute convincing evidence. I believe, however, that it can be accounted for by my own negligence in not thoroughly cleaning the bell-glasses before using them to cover fresh plants. Had the last experiment (No. 13), however, proved favorable to the theory I should have regarded it as being much more worthy of acceptation than I can now do. It is only after much patient work and careful consideration that I felt myself bound to differ from the eminent botanists abroad who do not accept the heterœcism of *Puccinia graminis* as established beyond question.

There are two other experiments not included in the thirteen which were performed by me that I think worthy of notice.

EXPERIMENT No. 36.—On the 2d August one oat plant with ten leaves upon it was inoculated with *Æcidium berberidis* spores. A very large quantity of ripe *Æcidium* spores was used —on the fifteenth day *Uredo* appeared upon the oat plant. On the 9th September (38th day), these *Uredo* spores were examined and found to be the *Uredo* of *Puccinia coronata*, Corda. Now had this experiment been carelessly performed the inference would have been that the *Æcidium* spores had produced the *Uredo* of *P. graminis*.

EXPERIMENT No. 40.—Six wheat plants were infected with the spores of *Uredo linearis* at 4 P. M. on the 13th August. On the 24th they all were simultaneously affected with *Uredo*, showing that the *Uredo* had reproduced itself in eleven days.

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Our Histological and Pathological Laboratories.

II.

In my previous article, published in the December number of this JOURNAL, I attempted a fair exposition and criticism of the outfits and manner of conducting the laboratories in connection with medical schools. My failing to clearly state my opinion as to what should constitute a good working laboratory, has caused numerous inquiries. In order to answer these and to bring the matter for discussion, I herein give my views on the subject.

First of all the room chosen should be so situated as to eliminate any possibility of tremor from outside causes, and so constructed as to be but slightly susceptible to motions within. This is all-essential. That it should be well lighted on all sides, is a convenience but not a necessity. What it lacks in natural light we can supply, and artificial light is to be preferred, owing to its steadiness. The floor should be oiled thoroughly and kept free from carpets or other covering. The walls should be smooth and of a dark color, thus preventing any chance of cross rays by reflection. Dark closet for storage, and chemicals injured by light; shelving for stock-bottles and material in hardening fluids; sink with hot and cold water; several aquaria for frogs, salamanders, etc., are all needed.

A cabinet containing various high-power lenses, binocular eye-piece, freezing microtomes and other apparatus, occasionally needed for demonstration or inspection, is an important addition.

Each student must be provided with a table, the particular style of which is a matter of taste. I much prefer Queen's revolving table, to which has been added numerous little drawers in which to keep cleaned covers, slips, brushes, knives, needles, and any small apparatus not in use.

On each table should be a micro-

scope with triple nose-piece and three or more lenses, of powers as follows: 1½" or 1", ⅔" or ½", ¼" or ⅛"; 2" and 1" Huyghenian eye-pieces, and ½" or ¼" solid ocular, all of which should drop easily into their places. This is a point that microscopists should insist upon—then, and only then, will the makers learn wisdom. The microscope should have a rack motion, and the fine adjustment should be behind, if for no other reason than convenience; the stage not more than ¼" thick, including carrier or mechannical stage, and certainly not less, as it cannot thus be made, and at the same time be steady. It must have a stop for the Maltwood finder. The mirror should swing above the stage, the diaphragm of the iris pattern, or so constructed as to work close to the slide. The swinging substage I would not insist upon, though at times it may be a convenience, it is not a *sine quâ non* as some would have us believe.

In addition, a camera lucida that can be used in all positions of the microscope is a necessity. Don't forget a polariscope in the outfit. This is indispensable; hence a stand having a shifting, polarizing apparatus, as the "lithological" stands, would, in some respects, be the best stand for our work. A bull's-eye condenser, eye-piece and stage micrometers, section cutters, knife and carriers, a lamp with an Argand burner are all necessary articles.

For dissection and tearing, a dissecting microscope, scissors, needles, knives, brushes, etc., must be provided each student, as well as turn-table, nest of porcelain saucers (not less than eight in a nest), mounting media, finishing cements, staining fluids, alcohol, etc., and capped bottles to contain them, these with small spirit-lamp, bell and watch-glasses, will complete an outfit.

A set of reagents for urinary analysis, acids, test-tubes, beakers, wash-bottles, water and sand-baths, large spirit lamp, drying oven, Bunsen burner, imbedding material, etc., should occupy the centre of the room on the chemical table.

A cabinet supplied with normal and pathological slides is a great help to students, as well as all the important current and standard literature bearing on the subject.

The course of instruction should begin with a thorough elucidation of the mechanical and optical principles involved in the manufacture of the microscope. I clip the following from the *Journal of the Royal Microscopical Society* for December, as bearing directly on this point: "Microscopists have for many years insisted that it is absolutely essential that histologists should be grounded in the theoretical principles applicable to the instrument with which they work, and that if this is not done, not only will erroneous interpretations of structure be put forward, but many points of importance will be altogether missed.

"In England (and America, too) this view has not been accepted in practice; and an histologist who attempted to determine the true structure of an object by experimental or theoretical optical considerations was a *rarissima avis*, indeed."

It would be well to acquaint the student next with the manipulation of his lenses, and the ascertaining of their powers. Follow this with instruction (practical of course) on the use of immersion or collar-adjustment lenses and eye-piecing.

A thorough study of the normal fluids of the body and the simple tissues should immediately be followed by the study of the same in diseased conditions. This method I prefer to that of postponing pathological histology until the entire course of normal histology has been gone over. The student thus saves much time and learns more rapidly the distinctive differences in the appearance of the tissues, after the simple tissues the membranes and organs are each considered in the way above stated.

I hope this paper will excite com-

ment by educators, and thus bring before us a subject on which we have been painfully silent, much to the injury of our students.

J. W. CRUMBAUGH.

PHILADELPHIA.

EDITORIAL.

PERSONAL.—We thought that Dr. J. Pelletan, editor of the *Journal de Micrographie*, had stopped the publication of his periodical. But the October number (1881) has been given to us by a friendly hand, particularly on account of an article concerning ourselves, which, although not such as would ordinarily be considered complimentary, is at least a rather outspoken *critique*, and more or less instructive for that reason. The nature of the article will be understood when we add that it is principally a translation from *The Microscope*, published by Prof. Stowell.

Now, if Dr. Pelletan does not treat us with more kind consideration in the future, we shall feel in duty bound to say some harder things about his peculiar transactions than we have ever said about anybody yet —and some of our readers will admit that such a criticism would be rather severe.

—o—

THE NORTHERN MICROSCOPIST.—We have received from the publisher some copies of *The Northern Microscopist* (London) for distribution among the microscopists of America, as advertised in another place. It is an illustrated monthly magazine which completed its first volume in December, 1881. We can commend it as an ably conducted journal, and would be pleased to have it widely circulated in this country.

CORRESPONDENCE.

A MUCH NEEDED STOP.

To the Editor:—For some months past I have been intending to offer, through this JOURNAL, a suggestion to our makers of microscope stands, and it is this: that they attach a thumb-screw in such a way that when the instrument is focussed on the object it can be securely set to that position.

While adding materially to the value of the microscope, particularly for soirée and exhibition purposes, it need not increase its expense beyond the merest trifle.

For public occasions the stop might be so arranged that the screw could be readily removed by the owner, and thus all tampering with the adjustment and consequent ruining of valuable slides prevented,—"a consummation devoutly to be wished," and which no notice of "hands off" and "please do not disturb the instrument" has hitherto accomplished.

Who will be the first to utilize this suggestion, and thus deserve the thanks of all microscopists?

J. T. BROWNELL.

MANSFIELD, Pa., Jan. 21, 1882.

NOTES.

—It is with no little satisfaction that we notice the publication of *Bulletin No. 1 of the American Museum of Natural History* of this city. It is the intention of the officers of the Museum to publish in this form, from time to time, the results of investigations conducted at the Museum, Bulletin No. 1 contains three articles by Prof. R. P. Whitfield, illustrated by wood-cuts and by four excellent lithograph-plates. It is in all respects a publication creditable to the Museum and to all concerned in its preparation.

—Messrs. Bausch & Lomb have devised a new immersion-condenser, which it is expected will soon be ready for sale. We have seen one of them, but have had no opportunity to give it a practical test. It seems to be ingeniously devised, and will doubtless prove very useful.

—Mr. A. A. Julien has published an article on "The Examination of Carbon Dioxide in the Fluid Cavities of Topaz," in which some interesting information regarding the nature of such inclusions, and the best methods of studying them is given. The article is published in pamphlet form, illustrated by four cuts.

—Prof. Bessey, in a late number of the *Botanical Gazette*, recommends the asparagus for histological study in the botanical laboratories. The stem of this plant is a good type of monocotyledons,

while for dicotyledons the pumpkin is a good representative.

—The eleventh edition of Messrs. R. & J. Beck's Illustrated Catalogue of optical instruments is a pamphlet of 176 pages, containing illustrations of the microscopes and accessory apparatus manufactured by that firm. It is a useful pamphlet for reference, and every microscopist should be willing to send 15 cents for a copy.

—Messrs. J. W. Queen & Co. have also recently issued the forty-ninth edition of their illustrated catalogue of optical instruments, which is likewise a book of reference, containing more than 180 pages.

—Dr. George M. Sternberg is now engaged in writing a book on practical microscopical work, which is intended to give a general knowledge of such subjects as are seldom treated in a satisfactory manner in our popular text-books. The work will be ready before long and we will take occasion to refer to it again as soon as the plan is more definitely announced. It will be illustrated by heliotype plates.

MICROSCOPICAL SOCIETIES.

The fourth annual reception of the New York Microscopical Society was held at Chickering Hall on the evening of the 3d of February. It was the most successful of all the public exhibitions given by the Society, and it was attended by about five hundred persons. The audience was highly appreciative, and included some of the most cultivated persons in New York society. The retiring President, Mr. R. Hitchcock, delivered the annual address, which is printed in full in this JOURNAL. After the address an exhibition of objects was given which, if not one of the largest, was certainly one of the best and most interesting of any that has been given in this city.

The exhibitions of the Society are given exclusively by members, with instruments belonging to them or to the Society. No member is allowed to show more than three microscopes, and the sole object of the exhibition is to combine instruction with entertainment. Among the objects exhibited, the following are worthy of especial mention: Circulation of blood in a frog rendered motionless by curara, by Mr. J. L. Wall. Circulation in the yolk-sac of a young trout and of a young salmon, both of which were provided by Mr. E. G. Blackford, and shown by the use of Holman's syphon slides. Mr. F. Collingwood showed the blood flowing in the tail of a fish; Mr. W. H. Mead showed cyclosis in *Anacharis* and Mr. Hitchcock the same in *Nitella*. Mr. F. W. Devoe showed a spider's nest with its pure-white eggs, a very beautiful object, and also the eyes of a living spider. Mr. E. C. Bogert showed some very beautiful insect eggs on a maple leaf. Several members exhibited different forms of living infusoria, rotifers, stentors, vorticella, etc., which they are now able to procure from Mr. Balen. Heretofore, there has been some difficulty about obtaining living infusoria in the city, when wanted for such occasions, but Mr. Balen has now removed it.

We have only mentioned some of the most interesting objects—the list included thirty-three different specimens.

The Society is in a prosperous condition, and we trust it may have a successful future under the direction of the new Board of Managers. Mr. Benjamin Braman is the President and Mr. C. S. Shultz Corresponding Secretary. The address of the Society is 64 Madison Avenue.

The Fairfield Microscopical Club met at the home of Dr. Hufford, Saturday evening, November 19th. The Club, having reached the close of the first year of its organization, proceeded to the election of officers for the ensuing year. The following officers were chosen: Prof. McCalla, reëlected President; Dr. Mohr, elected Vice-president; J. Grinstead, reëlected Treasurer; Geo. D. Clarke, elected Secretary.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

For a packet of frustules of *Amphitetras antediluviana*, send slide, or unmounted specimen to
K. M. CUNNINGHAM,
Box 874, Mobile, Ala.

Well mounted Diatoms on Alga, Polycistina, Zoophytes various, and other miscellaneous objects for other well mounted objects. Mounted Insects or parts of Insects preferred. W. FARNELL,
125 Walnut Street, Macon, Ga.

Well mounted Diatoms, etc., in exchange for first-class slides, or material. W. H. TIVY,
6th and Olive Streets, St. Louis. Mo.

A beautiful collection of wild seeds of Central Ohio to exchange. List furnished on application.
F. O. JACOBS, Newark, Ohio.

THE AMERICAN
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VOL. III. NEW YORK, MARCH, 1882. No. 3.

Reproduction of Closterium by Swarm-spores.

BY FRANK HOLLAND.

In works on the microscope, it is sometimes stated that besides the two usual methods of reproduction of the Desmidiaceæ, division and conjugation, there is sometimes a third method, by means of zoöspores or swarm-spores.

While looking over a drop of water from a fresh-water gathering, last August, I found a desmid of the genus

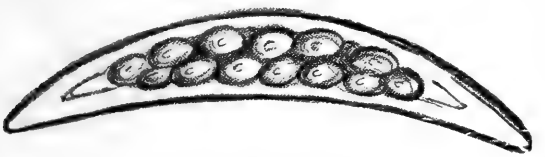

FIG. 8.

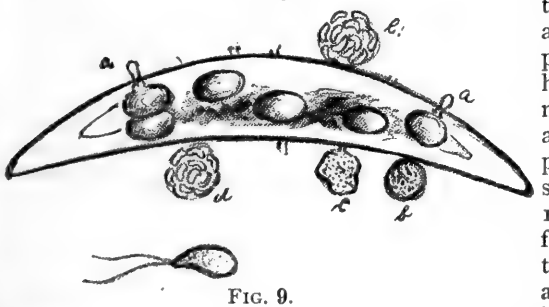

FIG. 9.

Closterium, which I think was reproducing itself by swarm-spores. In the hope that my observations will draw out more information on the subject from the readers of this JOURNAL, I record them as follows:

When I first saw the *Closterium* it had the appearance of fig. 8, all the endochrome evidently having been used up in making the greenish, oval bodies seen within the cell.

It was early in the forenoon that I saw the desmid, and as it presented such a remarkable appearance, entirely different from anything I had ever seen before in *Closterium*, I determined to study it, to learn, if possible, into what the bodies would develop. All through the forenoon it presented the same appearance, but in the afternoon, when I sat down to my microscope, I found there had been a change; some rounded points had grown out through the walls from the oval bodies within, each oval body seeming to have one, as shown in fig. 9 *a*, and also in fig. 10 *a*.

These points were transparent, the outlines of the walls being the only indication of them, and they were apparently destitute of protoplasm. For sometime, an hour or so, the desmid remained in this condition, after which balls of granular protoplasm (fig. 9, *b* and *c*, shown more enlarged in fig. 11) shot out very suddenly from the ends of the points—they were round at first, as at *b*, fig. 9, and then changed in a few minutes into a somewhat irregular mass, as at *c*, fig. 9.

The irregular masses kept changing to more irregular forms, from which the swarm-spores gradually grew; small masses of the protoplasm seemed to condense from the mass and to absorb the rest of it as they grew, until finally they attained the lenticular forms seen in the two round masses

of swarm-spores in fig. 9 *d* and *e*. A rapid revolving motion appeared in the mass of swarm-spores as they began to form, increasing in intensity as they grew, until finally they broke away from each other. In breaking away from each other, they scattered in all directions, and then it was seen that they had two rather long cilia (fig. 9), which were not previously observed. They swam very rapidly in a straight course, pausing for an instant with a jerk, and then resuming their path again. Their color was greenish. I should think there were twelve or thirteen of these swarm-spores in each mass, but owing to the rapidity of their motions I could not count them very correctly.

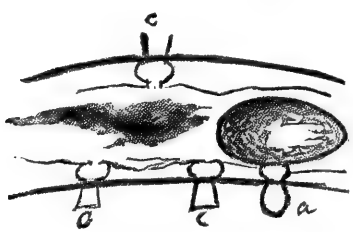

FIG. 10.

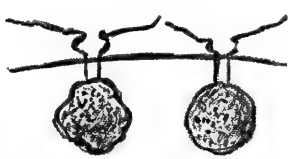

FIG. 11.

The masses of protoplasm (fig. 9, *b* and *c*) appeared on the surface of the frond at irregular times and places, two or three of the masses being seen at once, no definite order seeming to be observed in their production.

The whole process of the formation of the swarm-spores, from the first appearance of the mass of protoplasm on the outside of the frond to their final dispersion, did not occupy more than fifteen or twenty minutes.

FIG. 12.

On the empty frond I counted thirteen of the points where the swarm-spores had come out, and after they had all gone it appeared to be quite empty, nothing remaining in it but some wrinkled, olive-green substance It took the whole afternoon before the frond was entirely empty. While I was watching this desmid, a large amœba came gliding along and tried to swallow it, and I thought my observations upon it were at an end, but I was happily disappointed, for, after having half enveloped it he gave it up as being too large a morsel for him. He took from it, however, two or three of the masses of swarm-spores that were developing at the time, but three more bunches came out afterwards, developed, and swam away, the amœba's digestion evidently not being strong enough to affect the inside of the frond.

If any of the readers of this JOURNAL have seen the same method of reproduction of *Closterium*, and have been more fortunate than myself in following and watching the development of the swarm-spores into the full-formed *Closterium*, I would be glad to hear from them.

MANCHESTER, N. H.

Description of the Figures.

FIG. 8.—Appearance of the *Closterium* when first seen in the forenoon, with a ¼-inch objective.

FIG. 9.—Appearance of the same in the afternoon with the points (*a a*) and masses of protoplasm (*b c*) that have just come through, and the swarm-spores *d* and *e* forming. ¼-inch objective.

FIG. 10.—Point from one of the oval bodies *a*, before the swarm-spores have come out, and some of the points left (*e*) after they have gone, seen with the ⅛-immersion objective.

FIG. 11.—The masses of protoplasm as seen with the ⅛-objective, and a free swarm-spore.

FIG. 12.—Appearance of the frond after the swarm-spores had all gone.

The Motion of Diatoms.

BY C. M. VORCE, F.R.M.S.

It is with great pleasure that I observe the awakening of interest in this phenomenon. Like many others, I have watched faithfully the curious movements of the diatoms, in the effort to learn the means by which they are accomplished, but up to this time I have not been able to satisfactorily account for them on any theory I have yet heard of, so that I am still in the very unsatisfactory predicament of being unsatisfied with any of the theories advanced by others, yet having none of my own.

However, I have accumulated quite an array of facts bearing on the subject, and it seems to me that with the objectives now to be obtained, the solution of the mystery concerning this motion may yet be accomplished by some persevering observer. Therefore, I offer the facts I have observed in the hope that they may aid, in some degree, to develop the truth.

I have observed positive movement in the following diatoms: *Amphiprora ornata, Nitzschia sigmoidea, Nitzschia sp., Synedra sp., Surirella turgida Surirella biseriata, Surirella splendida (?), Cymatopleura solea, C. Hibernica, Cymbella cuspidata, Navicula cryptocephala, N. cuspidata, Pinnularia viridis;* and apparent movement in *Stephanodiscus Niagaræ*, in a *Gomphonema*, and in *Cymatopleura elliptica*. Also I have seen detached valves, free of endochrome, exhibiting apparently voluntary motion which, it is obvious, must have been caused by some force foreign to the diatom. Most of my observations have been made on fresh filterings from the water of Lake Erie, in which a large amount of flocculent matter was present, and in which infusorial life was abundant.

The common phenomena of the motion of diatoms are well described by the Hon. J. D. Cox, in this JOURNAL of April 1881, p. 66, and may always be seen in a gathering of diatoms where much light matter is present in the water. The same writer gives some observations reported by Dr. Wallich, and apparently considered by Dr. Wallich as very curious, in the JOURNAL of November, p. 206. The phenomena reported by both the above-named gentlemen have repeatedly came under my notice, as well as the growth of the silicious filaments referred to by Mr. Mills in the JOURNAL for January, p. 8; and I have observed a similar growth on frustules of *Nitzschia*. From my observations, I believe these silicious filaments to be mere adventitious excrescences, like a wart or tumor on the human body; yet I am satisfied that they affect the motion of the diatom on which they grow, just as a rudder or centre-board affects the motion of a vessel, without any connection with the cause of the motion. In one case I observed a very active *Nitzschia* having eight or ten of these bristle-like filaments, all on one side, one much longer than the others, and this frustule moved in curved lines, the filaments on the inner side, although ordinarily this diatom has a rectilinear course. Presently the long filament became entangled in some rubbish, and for a time the diatom swayed back and forth, as on a pivot, when suddenly the bristle broke short off, close to the valve, and the diatom thus freed moved away to some distance, resuming an almost straight course. Since I first saw these filaments on a diatom I have frequently recognized them, and doubt not they are often overlooked in the fresh gatherings and detached in boiling if the gathering is cleaned. By means of such filaments, if very small, a diatom might seize and carry along extraneous matter with which it came in contact, as it is often seen to do, without the filaments being perceived; but this would not account for the traveling of particles along the diatom while it is held fast, as so commonly happens.

Many of the phenomena connected with the motion of diatoms seem to

indicate that the frustules are enveloped in a membrane, and such I believe to be the case. This enveloping membrane, if adhesive, would cause many of the appearances noted, provided the motion be accounted for; but adhesiveness of the diatom would not of itself cause motion. I have often seen a small diatom moving along beside a much larger, stationary one, cause the latter to revolve by the friction, often partly overturning it. But in the cases where extraneous matter is seen adhering to, or trailing after a diatom, how do we know that the adhesive property does not reside in the adhering matter and not in the diatom at all? I have often seen such masses of flocculent matter adhere to entomostraca and rotatoria when they happened to brush against it, and remain attached some time until detached by the violence of their movements.

The remarkable alternation of motion seems to me a very strong objection to the ciliary theory, and equally so to that of the prehensile filaments. No other ciliated or flagellate organism that I know of exhibits such alternation, but whether animal or vegetable, when free to move they swim hither and yon in a purposeless and indefinite course, without limit. But if prehensile filaments exist, they should, to be in accord with other provisions of nature, bear a relative proportion in size to the diatom by which they are borne. Yet, in large diatoms, like *Amphiprora ornata*, *Surirella splendida*, *S. turgida*, etc., when active and moving with great force, no trace of cilia, pseudopodia, filaments or anything of the kind has yet been discovered. I have watched a large, thick *Surirella* plowing its way through tangled masses of *Tabellaria*, and sweeping before it masses larger than its own bulk, and hoped to find some trace of the means by which the resistless motion was imparted, but without success, although I brought to the task objectives capable of resolving the *Amphipleura pellucida*. No trace of currents, of cilia, or any external appendages could be seen, nor any motion in the endochrome of the diatom. I have also observed that these large diatoms do not show the same attraction towards loose particles in the water which the smaller ones do.

I have seen living diatoms, both still and moving forms, with a substance adhering to them which had exactly the appearance of a fragment of an amœba, but without the movement natural to the latter. And I have seen the same substance adhering to dead diatoms entirely free from endochrome. In all the cases I am convinced it was foreign to the diatom and had no connection with the motion of the diatom to which it adhered.

Most diatoms, even when unobstructed, move with a quivering or staggering motion, much like a drunken man, which does not seem consistent with ciliary action, or with currents produced by osmotic action, and besides we should expect the currents produced by cilia or any other force capable of moving the diatom, to be strong enough to move adjacent particles when the diatom is held fast. Yet we do not see free particles moved, or any evidence of current in the water except where there is contact with the diatom. Frequently we see a small mass moving along the diatom while another mass, apparently in contact with it, is not affected until the moving mass strikes the stationary one, when both move as one, or as if stuck together by some adhesive substance.

The appearance mentioned by Mr. Mills, of a clear space surrounding diatoms like *Cyclotella* is not an invariable characteristic. I have seen the complete space around some frustules, while others of the same species in the same gathering were matted with light stuff, and often themselves matted in groups, while all, judged by the appearance of the endochrome, were equally alive and vigorous. In

addition I have at times noticed a peculiar clear space adjoining one side of a diatom, as if a drop of some invisible oil was attached to it, while everywhere else the dirt and loose matter in the water adhered to the frustules. The same clear space is often seen around other particles, such as sand and dead diatoms, etc. If a layer of jelly-like substance did in fact surround the living diatom, and had the power of wave-like motion in its substance, it might give rise to motion of the diatom, like the creeping of a snake; but it seems impossible that a layer of such substance sufficient to accomplish the result, especially in large diatoms, should escape detection, and the alternation of motion would still be unexplained.

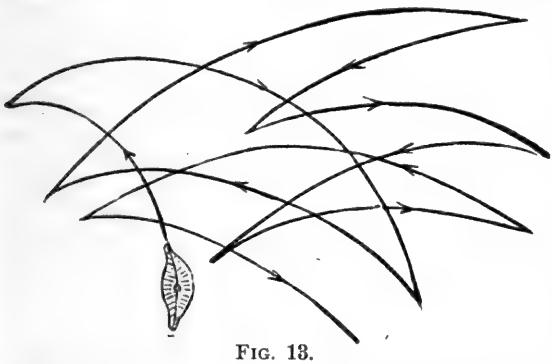

FIG. 13.

But in some cases, at least, the shape of the diatom has an influence upon its motion. *Amphiprora ornata*, which has a half twist, moves through the water endwise, with a rocking motion exactly like that of a vessel in the trough of the sea, and the curved webs or projections on the sides of the valves would give just such a motion to the frustule when forced through the water, but if prehensile filaments caused the motion the effect of the shape of the diatom would be little or nothing, and in clear water prehensile filaments would affect nothing unless they could fasten to the shifting atoms of water as to a solid body.

In conclusion, I append a diagram of the course followed by a very active frustule of *Cymbella cuspidata* observed moving in clear water: the diatom is drawn at the starting point, and the arrows indicate the course in which it moved. None of the accredited causes of motion in diatoms seem to me to explain satisfactorily all the phenomena observed.

——o——

Binocular Microscopes.

The question is often asked by purchasers of microscopes, whether there is any real advantage in binocular over monocular instruments. In so far as we regard the question in its purely practical aspects, it is capable of a definite and a satisfactory answer; but when we come to decide upon it from theoretical grounds—to state just what effect any particular binocular arrangement will have when applied to the examination of a specified object, to explain how much of the appearance of relief is real, and how much is merely a mental impression produced by the two images in the two eyes—the problem presented is a very difficult one.

We shall, therefore, confine ourselves to the practical side of the subject in this contribution. If the question is, whether there is any advantage in a binocular microscope in studying the form of objects—whether the appearance of relief that it gives is necessary to enable us to form a correct idea of the true shape of objects in which the appearance of relief is most striking—the answer must be a decided negative. It is true that the binocular does reveal more of the form of an object at the first glance, than the monocular; but it is a matter of experience that those who use only one eye in microscopical work, never make the mistake of supposing that an object is flat merely because it seems to be so. A very short experience enables one

to form a perfectly correct idea of the shape of any object by a few turns of the focussing screw. Hence, persons whose means are limited, and who desire to invest a small sum of money in a microscope to be used for purposes of study, would do well to forego anythought of purchasing binocular stands.

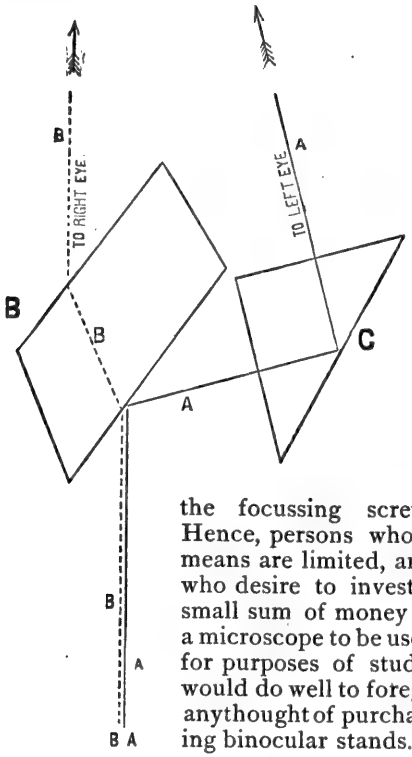

FIG. 14.

On the other hand, there are certain qualities of binoculars which commend them to all workers who can afford the additional cost. Apart from any stereoscopic effects, it is doubtless true that the use of the two eyes whenever possible, renders continued observation less tiresome than when only one can be applied to the tube. Some writers have stated that with a monocular, one eye is overstrained while the other is not used at all, contending that by using the binocular that trouble is overcome. The two eyes should be used alternately with the monocular, hence they both ought to become trained for sharpness of vision; but we doubt if the binocular aids in the way assumed, for we are inclined to believe that, although both eyes are simultaneously employed with the binocular, the right eye does most of the real work, the left eye only supplementing its fellow and giving the binocular effect. However this may be, there is a certain ease in working with binoculars, which doubtless makes the strain upon the eyes less, than with monoculars.

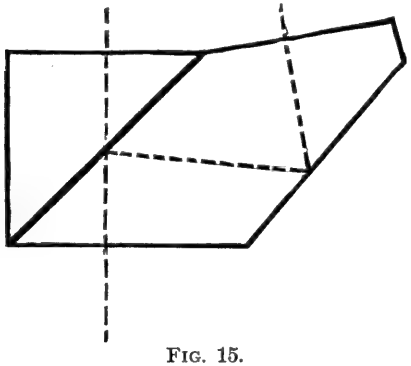

FIG. 15.

The stereoscopic effects while not of great practical importance, as already stated, certainly render many objects more attractive to look at. For this reason a microscope for the entertainment and instruction of friends should certainly be a binocular. But it should not be forgotten that the angular aperture of the objective must not be too large, as then the stereoscopic effect will be exaggerated, as Carpenter has well shown. He found that a ½-inch of 40° gave the true stereoscopic effect.

It should be remembered that the ordinary form of binocular cannot be advantageously used with objectives of less than half an inch focus. Therefore, the kind of work to be done should also be considered in selecting the stand.

We will now briefly refer to some of the different forms of binoculars, but a detailed account of them cannot be given here. Most of the cuts are taken from the article by Mr. Geo. E. Fell, on "The Binocular Microscope and Stereoscopic Vision," published in the *Proceedings of the American Society of Microscopists*, and

for their use we are indebted to the courtesy of Prof. Kellicott.

Fig. 14 represents Powell & Lealand's non-stereoscopic binocular

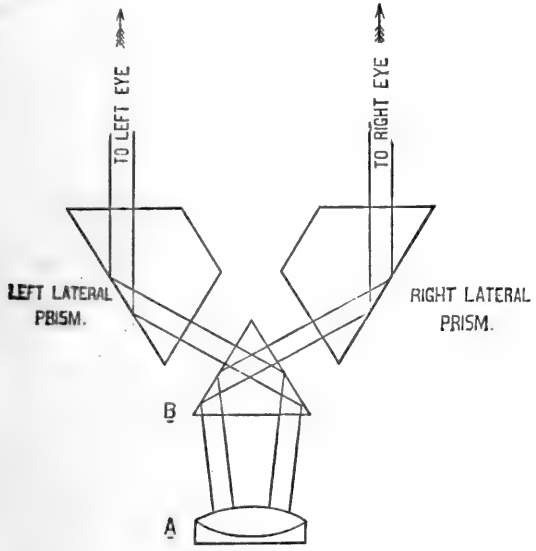

FIG. 16.

which may be used with high-power objectives. The prisms are mounted in a tube which can be substituted for the tube holding the Wenham prism, now in common use. The rays from the objective are partly transmitted and partly reflected by the surface of the prism *B*, and their

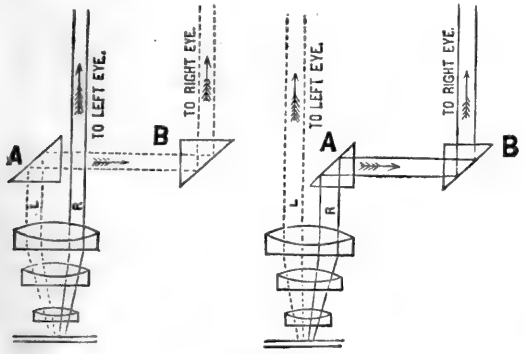

FIG. 17.

course can be followed by means of the diagram.

Mr. Wenham has devised a prism for use with high powers, represented in fig. 15. It is mounted the same as the ordinary Wenham prism, and can readily be substituted therefor.

Fig. 16 represents the Nachet stereoscopic binocular, and fig. 17 the Nachet stereo-pseudoscopic arrangement. It will be observed that the two figures represent the same instrument with one of the prisms in different positions, giving a stereoscopic effect in the first figure, and a pseudoscopic effect in the latter.

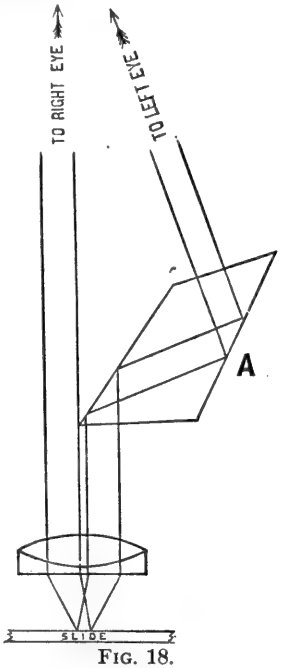

FIG. 18.

The ordinary Wenham binocular is represented in fig. 18. This is the form in almost universal use in this country.

Fig. 19 represents Prof. H. L. Smith's arrangement by which the rays from the objective are partly transmitted and partly reflected by the plate *D*.

The first binocular of all was an

American invention, devised by Dr. J. L. Riddell, of New Orleans. A full description of this instrument, with cuts, will be found in Vol. I of this JOURNAL.

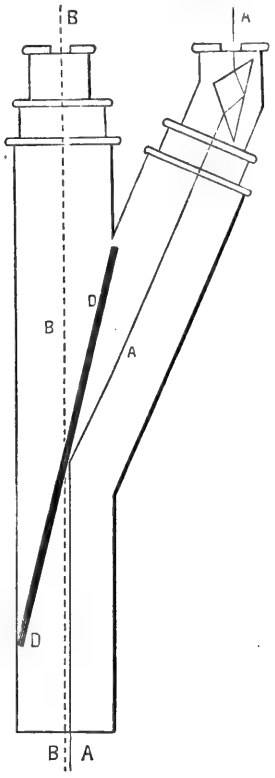

FIG. 19.

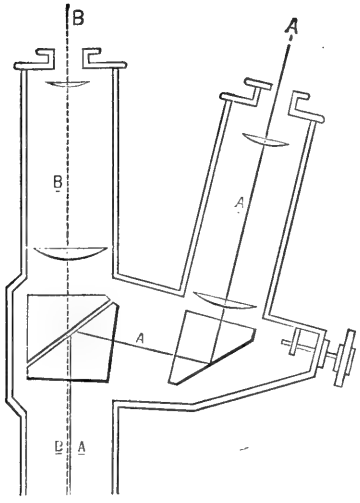

FIG. 20.

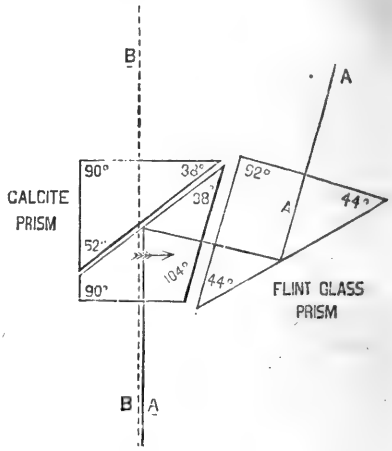

FIG. 21.

The (Abbe binocular eye-piece fig. 20), was fully described in this JOURNAL some time ago (Vol. I, p. 201). A similar arrangement was described by Prof. F. A. P. Barnard, represented in fig. 21. The latter, however, was not an ocular, but was intended to be used in the tube. It differs from Prof. Abbe's device, in having a prism of calcite.

The Vertical Illuminator.

[Dr. E. Van Ermengem recently recounted his experiments with the vertical illuminator before the Belgium Microscopical Society. As this instrument has lately attracted considerable attention in this country, as well as abroad, the following summary from the *Bulletin des Séances*, may prove of interest.—ED].

This apparatus, invented in 1866, by Prof. Hamilton L. Smith, has been for some time used in a manner different from that designed by its inventor. With the homogeneous-immersion objectives it gives results which have arrested the attention of many microscopists, and which have been the object of interesting discus-

sion at one of the late sessions of the Microscopical Society of London.

The speaker has made some improvements upon the model of R. & J. Beck, and added an adjustable diaphragm, by means of which the instrument is made more useful and gives better results. Moreover, the reduced dimensions of the apparatus thus modified permits of its use—with Zeiss homogeneous objectives—on microscopes of the smallest model. With a very simple and cheap accessory one may thus resolve the most difficult tests, *A. pullucida* and the 19th band of Nobert's plate, more perfectly than with immersion condenser, Woodward's prism, swinging substage, etc., which are only applicable to large microscopes.

By means of an apparatus constructed by M. De Simpelaere, of Brussels, and a $\frac{1}{18}$-inch objective of Zeiss, several tests were successfully shown,—*Surirella gemma*, *Navicula rhomboides*, *Amphipleura pellucida*, and the scales of *Podura plumbea*, were resolved with extraordinary clearness. Under a magnification of 3200 diameters, the striæ of *A. pellucida* appeared manifestly separated into pearls or dots. The appearance of *Pleurosigma angulatum* under this illumination is very unexpected. The markings resemble the alveolar or hexagonal structure of certain species of *Triceratium*, *Coscinodiscus*, etc. This special illumination affords a new confirmation of the opinion held by some microscopists regarding these markings, and which M. Rutot reproduced at the *séance* of October 30th, 1880, *à propos* of the microphotographs of this *Pleurosigma* prepared by Dr. Günther, of Berlin.

The appearance of solidity, of relief, afforded by objects thus illuminated, the preservation of their natural colors, the clearness presented by the smallest details of their surface, have led many observers to admit that the effects are due to an illumination very similar to that which reflected light produces with opaque objects. But Mr. Stephenson seems to have demonstrated that the rays condensed upon the object, at least when it is transparent, as are the silicious valves of the diatoms, are not reflected from the superior surface, and that they traverse it, on the contrary, without illuminating it. Only one portion of the rays, of which the obliquity exceeds the critical angle (41°), suffer total reflection from the inferior surface of the object, and instead of passing into the air, illuminate it by making it self-luminous. Thus is explained why the apparatus only produces this particular illumination with objectives having angle of aperture greater than the maximum of dry-objectives, more than 180°, and on preparations mounted dry having the object adhering to the cover.

Dr. Ermengem, moreover, called the attention of the members to the advantage of this method of illumination in the study of certain histological elements. There are many anatomical preparations which can be temporarily mounted dry on the cover-glass. Human blood cells presented an extraordinary appearance, in their bright-red color, their very appreciable relief, and the clearness with which the slightest inequalities of their surfaces are visible.

——o——

The Limiting Diaphragm, or Aperture Shutter.*

For many years past we have heard declamations against the practical value of wide aperture objectives, principally, however, upon the ground that they do not possess *penetration*, though all seem agreed that they do define much better than those of small or medium angle. Even Dr. Carpenter, the champion of medium angles, in the last edition of his work, p. 732, seems at last to prefer wide apertures, for in the only instance in which he has expressed an opinion upon the structure of insect scales *from his own study* he writes: "The

* From *The Northern Microscopist.*

"author has fully satisfied himself by "his own study under an oil immer- "sion $\frac{1}{25}$ of Messrs. Powell and Lea- "land of a *Podura* scale illuminated "by the 'immersion paraboloid,'" etc., etc.

It is well known that the wider the aperture of the objective, the less the working-distance may be, though this does not depend upon the aperture alone. A reference to pp. 257, 282 and 283 of this journal will show this clearly, if columns *a*, *d* and *g* are compared; we do not, however, wish to enter into this question at present, but will endeavor to show how penetration may be given to wide angle lenses.

It seems upon inquiry that some of our opticians have for some time past produced a half-inch objective for use with the binocular, by placing a diaphragm of smaller aperture than usual behind the back lens of the objective. The half inch of 60° is thus easily reduced to 40°, and the penetration consequent upon such reduction is by this means obtained.

For some time past we had been using stops of blackened card-board, and as these were not very convenient we had a conversation with Mr. J. B. Dancer of Manchester, as to the utility of making an "iris" diaphragm for the purpose, when he produced a graduating diaphragm made ten years ago, but to the best of our knowledge, our idea has never been published.

It will be seen that this form of aperture shutter enables the operator to adjust his objective to any aperture he wishes, and this cannot be effected upon any older plan without having a large set of stops on hand. The closing of the shutter does not contract the absolute size of the field, but only the brightness of it, and the true value of *penetration* can easily be observed without moving the eye from the tube.

The value of wide apertures for good definition may also be seen when using this "shutter." If Topping's admirable preparation of the proboscis of the blow-fly be observed with an inch objective having an air angle of 30°, the view is superb, the *pseudo-tracheal* markings come out well defined and sharp; but close the shutter until an angle of 14° or less is obtained and examine again, when it will be found that the definition is not nearly so good, while there is more penetration, the whole of the pseudo-tracheal tube being observed under one focussing. While in this condition, the eye being still applied to the tube, open the shutter to its full extent, and the effect of wide aperture will demonstrate itself.

Perhaps the best object to show the amount of *penetration* possessed by objectives of low angle, may be found in the microfungus *Myxotrichum deflexum*, or *M. chartarum* observed under the one-inch objective. The former object consists of little patches of grey downy balls, from which arise a number of radiating threads furnished with a few opposite and deflexed branches. Under an inch objective of 30° air angle but few of these branches can be seen under one focussing, the remainder being enveloped in a haze of light; but if a central layer be focussed, the simple closing of the shutter will suffice to bring the superior and inferior layers into view, though of course the image is not so bright or so well defined as before.

The objection to wide angles, that they do not possess penetration may now be fairly said to have broken down; its other phase, that of working-distance, we will treat of in a future number.

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Staining of Living Unicellular Organisms.*

K. Brandt finds hæmatoxylin and Bismarck-brown suitable coloring materials with which to stain Protozoa in the living state. For Amœbæ and Heliozoa a dilute solution of hæma-

*Abstract, in *Journ. Royal Micros. Society.*

toxylin in water is allowed to act for a short time; in any case the process must be limited to an hour, as even Amœbæ succumb to a longer treatment. Pure water should then be allowed to replace the staining fluid. The nuclei are found stained pale violet. By this method the author has discovered nuclein in the form of numerous round granules in the endosarc of *Amœba proteus*, Leidy, measuring from $\frac{1}{1600}$ to $\frac{3}{1000}$ mm. in diameter; they have the same optical properties as the nuclei, and react chemically in the same way, and stain readily and deeply with hæmatoxylin. The bulk of extra-nuclear nuclein may be seen in old specimens to exceed that of the nucleus itself, and in young individuals to exclusively represent the nucleus The author has been led by the remarkable appearance of the so-called nuclei to regard them as reproductive bodies, and to consider the nuclein-granules as representing the nucleus proper, for the membrane enveloping the nuclei appears in this amœba to consist of cellulose, it being insoluble in solution of caustic soda, but dissolving in ammonia-oxide of copper.

Hæmatoxylin at first produces no visible change in the liquid of the contractile vacuole; later this assumes a yellowish tint, and finally becomes brown shortly before death: the acid reaction of the liquid is thus proved. Bismarck-brown stains the nuclei of dead cells, but the only parts of Protozoa affected by it in the living state are the fatty granules and a peculiar mucous substance resembling cellulose. The solution should have a strength of either 1 to 3000 or 1 to 5000; it is best adapted for Heliozoa, Amœbæ, and Flagellata, which remain quite healthy even after staining for several hours, and when the parts above-mentioned have assumed a deep brown; if replaced in pure water the color is long retained by the fat-granules. Double-staining may be effected by first using Bismarck-brown for an hour, and then hæmatoxylin for a much shorter time; the protoplasm alone remains uncolored. The difference in their colors shows which of the granules are fatty and which consist of nuclein. When death sets in, in consequence of this treatment, the nucleus becomes very deeply stained, and the protoplasm acquires some color. The action of cyanine or quinolein blue, used in the proportion of 1: 100,000 or 1 : 500,000, recommended by Certes for Infusoria and histological elements, is essentially the same as that of Bismarck-brown. Certes finds that Infusoria also stain with Bismarck-brown.

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Microscopical Laboratories.

In the February number of the JOURNAL, there is an article by Dr. J. W. Crumbaugh, in regard to which I would like to offer a few words. Many of his suggestions are good, but in some respects I would beg leave to differ with the writer. Dr. Crumbaugh's idea is to surround the student with altogether too much and too expensive paraphernalia, which has a tendency to discourage him at the start. It has been my experience, and is also so taught by the leader of pathological science, Virchow, that the more simple the microscope the better. Better work can be done without fancy rack stages and a multitude of screws, as has been illustrated by some of the work done by students under Prof. Bunker, of L. I. Hospital Medical College. In place of Queen's revolving table, I much prefer tables made square or long, of heavy, polished wood, well oiled, and fastened firmly to the floor. It has always seemed rather strange to me why some microscopists prefer artificial to natural light; the former is much more trying to the eyes, and according to my idea, for general work it is not so good. I would have the light come in from only two sides, east and north. The material for the student to examine should always be as fresh as possible, and when pathological,

the history of the case as known should be given with the preparation. After such a course, when the student comes to the work of every-day life in the routine of practical medicine, he finds laid a solid basis upon which to extend his future observations.

All physicians cannot be specialists with the microscope, but all should know the pathological difference between fatty degeneration and amyloid degeneration when they see it. Yet how many do? I venture not ten per cent. of them, and so long as you insist upon surrounding the student with so complicated an outfit as the writer above mentioned would suggest, so long will we continue to turn out physicians from our medical schools ignorant of the essential principles of histology and pathology. I well remember while I was a student in the Pathological Institute in Berlin, that the great endeavor of Virchow was always to simplify things as much as possible; and had I been obliged to buy my whole outfit, the cost, including my microscope, would not have exceeded seventy-five dollars. In the future I may have more to say upon this subject.

H. HATCH, M. D.

QUINCY, Ills.

EDITORIAL.

Subscriptions.—Remittances for subscription should be made by post-office money-order, by drafts payable in New York, or in registered letters. Money sent in any other way will be at the sender's risk. A receipt will be immediately given for money received by open mail.

SUBSCRIBERS IN GREAT BRITAIN.—For the benefit of subscribers in Great Britain, we are pleased to announce that we have made arrangements with Mr. W. P. Collins, Bookseller, of London, so that he will act as our authorized agent, through whom all business connected with the JOURNAL can be transacted. He will have full sets of the JOURNAL constantly on hand, and will be able to furnish back numbers of the present volume more promptly, perhaps, than we could possibly do if orders were sent directly to us.

We hope this arrangement will prove entirely satisfactory to our subscribers in Great Britain.

—o—

RULED BANDS.—Some gentlemen in Elmira have been amusing themselves by resolving ruled plates. Drs. Gleason and Up de Graff have resolved the eighteenth band of Fasoldt's plate, which is said to have 120,000 lines to the inch. Dr. Gleason has stated this so positively that we cannot doubt the resolution of that band, but before we are convinced that lines as close as 120,000 to the inch have been resolved, we must have satisfactory proof that the lines of that band are ruled so close as that. Such proof can be given by photography, and when Dr. Gleason returns from Florida, where he has gone to shoot alligators, we hope he will have the band photographed and the lines counted.

We shall discuss the subject of resolution more fully next month, and endeavor to indicate the value of ruled plates as tests for objectives. Just now we wish to ask some questions in regard to Mr. Fasoldt's announcement that he can rule, and has ruled, a band having 1,000,000 lines to the inch. It seems that Mr. Fasoldt sets his machine to rule lines in that proportion, and then asserts that the lines are ruled because they show the diffraction spectra. The question we wish to put to Mr. Fasoldt, and to the scientific world, is this: Are those spectra any proof of the presence of separate lines?

We would like Mr. Fasoldt to inform us how fine the individual lines of his wonderful plate are? If the plate has 1,000,000 lines to the inch, the individual lines cannot be broader than half a millionth of an inch! Can such fine lines be ruled? Then it is a question in mechanics, whether a tool can be made so steady that it can draw a line without a tremor of

half a millionth of an inch—for if not, then the lines of the plate must run together.

In regard to our first question, we have already some evidence that Mr. Fasoldt's assumption is not justified.

Prof. W. A. Rogers ruled a plate with his machine set for 500,000 lines to the inch, making every fifth and tenth line longer than the rest. He then measured the long lines, where they projected from the band, and found that they were so broad, that they overlapped each other, leaving no spaces between them. Evidently, therefore, the band of 500,000 lines did not consist of distinct lines. The spectra were, nevertheless, clear and bright. Hence, we are forced to conclude that the spectra do not prove that Mr. Fasoldt's plate contains 1,000,000 lines to the inch.

—o—

Illumination and Resolution. —It is not unfrequently the case, as we have had sufficient reason to know, that when a person first tries to resolve the *Amphipleura pellucida*, or some other difficult test-object, with an objective that is quite capable of showing the lines, the result is very unsatisfactory. Sometimes the lines cannot be seen at all, and we have known persons to own such objectives for months, without being able to show the lines. There is a "knack" about it, to be sure, but it is by no means difficult to acquire. In most cases the fault is entirely in the illumination. An adjustable objective will not resolve well unless the proper adjustment is made, and the lines on a delicate test-object cannot be seen without careful focussing—all this is well understood at the beginning. Nevertheless, in most cases the greatest difficulty met with by the novice is in the management of the light. A few suggestions concerning this matter may prove of assistance to some of our readers.

One may sit at a table and put the elbow on the partly opened drawer, and hook the heel of the left foot over the front round of the chair, as Prof. J. Edwards Smith has directed in his celebrated book. But we can assure the reader that lines on a *A. pullucida* can be reasonably well seen without any such formalities. In truth, one of the best resolutions we ever saw was shown by Mr. Herbert Spencer, in his shop at Geneva, with light from a cloudy sky, the microscope standing on a packing-box, which was also used as a seat, if we recollect aright.

The novice will not succeed as well by daylight as with light from a lamp, and the simple, low hand-lamp with a flat wick is the best of all. A student-lamp is not good for this work. To get the best result, remove all substage accessories and also the mirror. Then fasten the Woodward prism, hemispherical lens, or whatever attachment may be used in their stead, to the test-plate with glycerin. It is a good plan to paste a strip of paper on the back of the slide for the side of the prism to rest against. This prevents the prism from sliding down if the glycerin does not hold it well. The microscope should now be arranged so that the source of light will be as nearly as possible at a right-angle to the axis of the tube. If the stand is a low one it may be raised on a cigar box. Place the lamp about a foot from the centre of the stage, on the left, with the edge of the flame toward the stage. Then introduce a small condensing lens and focus the flame carefully upon a piece of white paper placed upon the stage. Then put on the slide, with the prism attached, and it will not be difficult, by slight changes in the position of the lamp or bull's-eye, to make the lines visible.

It is much more easy to make a resolution in this way than by using the mirror. It is necessary to have a sharp point of light upon the object in order to get the best resolution, and if the mirror is used it should be carefully focussed upon the object. However, a large mirror is very difficult to use in this kind of work, for

there is a flood of light from it, which is detrimental to good resolution.

—o—

A NEW FORM OF VERTICAL ILLUMINATOR.—*A propos* of the article we print this month, it may be well to once more call attention to the ingenious device of Prof. W. A. Rogers (we believe it was invented by him), made by Mr. Tolles. We refer to the reflecting prism fitted into the objective just back of the front lens. By throwing light upon the exposed face of the prism, it is reflected down through the front lens upon the object, and certainly gives a most excellent illumination. Prof. Rogers has used it in the examination of his ruled plates with great satisfaction. A member of the New York Microscopical Society, Mr. James Warnock, has recently received from Mr. Tolles, a $\frac{1}{8}$-inch objective of large aperture, with this attachment, which gives a fine definition of the lines on *Amphipleura pellucida*. Before long we intend to allude to this subject again, and to give an account of a comparison between this and the common vertical illuminator.

Meanwhile, we wish to suggest another form for a vertical illminator, which, it seems to us, might prove to be better than the ordinary one, and certainly more convenient for use. It was first described at the meeting of the New York Microscopical Society, held March 3d. Instead of the reflector now used, we suggest a small glass reflecting prism to be placed in the nose-piece in the same way and in the same position as the Wenham binocular-prism, and in the case of binocular microscopes it should replace the latter. The back surface of the prism, which receives the light, may be either plane or curved—it might be found advisable to make this surface act as a lens to throw the light upon the back of the objective in the most advantageous manner for illumination. All parts of the prism not used should be blackened, so that no light except what passes down to the objective can enter the tube. A rotating diaphragm can be added, working in front of the exposed surface of the prism; but this would probably be an unnecessary expense.

—o—

ABOUT STANDS.—The articles we have lately published about stands have aroused considerable interest in various quarters. The Editors of the *Botanical Gazette* have shown their full appreciation of the importance of the subject by asking: "Does it follow that if such work can be done by ordinary instruments, even more astonishing results can be obtained by using finer ones? Or, is it a fact that the extra appliances, etc., are more things of 'fuss and feather' than fruitful additions to biological laboratories?"

The first question we have answered clearly enough. The second deserves a little more attention. Some accessories are certainly important, but there is a long list of them which embraces many that are quite useless for purposes of investigation, and very many others that are mere conveniences—good articles to have if one can well afford them, but which are not required.

It would, perhaps, surprise many novices to learn how very few of the accessories in our catalogues are of great practical utility for purposes of investigation. These few, however, are almost indispensable for some kinds of work; therefore, we have advised the purchase of microscopes with substages in every case.

—o—

NEW SPONGES.—In the *Proceedings of the Academy of Natural Sciences*, of Philadelphia, Mr. Edw. Potts has two short notes about fresh-water sponges. He considers that the characteristics of the statospheres and their spicules furnish the only reliable distinctions between the fresh-water sponges. Some American forms differ from the typical English species, both in the shape of the spi-

cules and in their arrangement, but it is uncertain whether these will require new generic names, or if they should be included in Carter's genera.

An American form allied to *Meyenia*, Carter, has led Mr. Potts to establish the genus *Heteromeyenia*, in which the shafts of the birotulate spicules are not uniform in length. Another new genus, *Carterella*, has been made, to include a form described by Mr. Potts last year, before the Academy, as *Spongilla tentasperma*, and mentioned on page 16, of Vol. II of this JOURNAL. The distinguishing peculiarity of this genus, that the tube surrounding the foramen of the statosphere is elongated, and divides into 2–5 long tendrils by which it remains attached to stems or roots during the winter, reminds us that probably it was a form of this genus that we found in the Lehigh River, near Bethlehem, last summer, during a few days sojourn with Mr. Wolle. The elongated, branching tube puzzled us at the time, but it seems clear enough now that the form we observed was *Carterella tenosperma*. Another species, *C. tubsiperma*, having a still longer tube, was discovered by Prof. Kellicott and Mr. Henry Mills, of Buffalo. A third species, *C. latitenta*, with long, broad, flat and ribband-like tendrils, has been found by Mr. Potts, which he states to be the most conspicuous and peculiar of our American forms.

—o—

MOUNTING.—It seems to us quite an unfortunate circumstance that many of our most able investigators with the microscope regard mounting as a difficult and troublesome operation. It is seldom that any of them deny the value for future reference, of the preparations they make, and frequently we hear them express regrets that they cannot refer to some specimen that has not been preserved, either to verify a previous observation or to supplement it by further examination. While we do not advise that specimens should be preserved without regard to their intrinsic value—a course too often followed by amateurs, which eventually results in a grand cleaning up of slides of worthless preparations—there can be no doubt that in the course of regular work many specimens are found which show different points of structure far better than these can be demonstrated a second time by days of labor. In this article we have especially in mind those busy, professional men who value every moment of their time, and who, not having learned any simple process for mounting, are discouraged from attempting it by the multiplicity of processes and cements given in the books. To them we wish to say, that with a turn-table, only two cements, a bottle of Canada balsam, a few needles mounted in wooden handles, some slides and covers, and a few simple articles that are sure to be at hand, any specimen whatever can be mounted in five minutes, or at least so preserved on a slide that the finishing touches may be added at any convenient time.

For almost every specimen that requires to be mounted in a fluid, such as glycerin, water or other preservative, the only cement necessary is a simple solution of shellac in alcohol. The proper method of using this has already been described in this JOURNAL (Vol. I, p. 149).

It has stood the test of long use, and the practical operations of mounting are expeditious, and exceedingly simple to carry out. Shellac cement is one of the best and most reliable cements known; it hardens rapidly, and it is even practicable to prepare a cell of considerable depth, and to use it for mounting within an hour. The use of shellac alone, however, is liable to the objection that it becomes brittle, and the cover-glass is then easily detached if the slide is dropped. To prevent such a mishap, the slide should be finished with a mixture of equal parts of asphalt and gold size.

Instead of cementing the cover-

glass with shellac, it is sometimes done with hard Canada balsam dissolved in benzole. This is an excellent plan when the preservative fluid is water or an aqueous solution of some chemical substance. However, usually shellac alone is sufficient.

As to the operations of mounting, very little practice is necessary. The time required is reduced to a minimum if all the apparatus required is placed in a single box, and kept ready for instant use. We have followed this plan for years, and whenever we are looking over a collection from a stream or pond and find a rare or especially interesting specimen that we wish to preserve, we have merely to take down our mounting-box and turn-table, and, without losing a minute of time, proceed with the mounting.

Finding, for instance, a species of algæ, we select a slide having a ring of shellac previously prepared upon it, and place it on the turn-table. Then a fresh coat of shellac is added and a drop of preservative placed in the center. The alga is then transferred to the slide and the cover-glass immediately applied and pressed down around the edges, the superfluous moisture wiped off, and the cover sealed down by another coat of cement. The slide is then ready to be put away until a convenient time for finishing it with the asphalt and gold-size.

Mounting in balsam is also a simple operation, and has been fully described in this JOURNAL (Vol. I, p. 161).

We trust the suggestions of this article will not be lost sight of by professional men. Five or ten minutes occasionally devoted to the mounting of specimens may result in great satisfaction afterward.

——o——

THE CAUSE OF DIPHTHERIA.—Supplement No. 17, of the *National Board of Health Bulletin*, contains the full report of the studies of Drs. H. C. Wood and H. F. Formad, conducted during the years 1880 and 1881. The "Bibliographical Introduction" gives a number of references to important articles written both in favor of and opposed to, the idea of a fungoid origin of this disease. The second chapter relates to studies upon the human subject. It is here affirmed that the micrococci of diphtheria cannot be distinguished by microscopical examination from such as are found in cases of ordinary throat inflammation, or furred tongue. To determine whether micrococci are always present in diphtheria, a large number of cases were examined, embracing those of a mild and of a malignant nature. In the mild form of the disease, and even in the less severe cases of the malignant type, micrococci are usually not found in the blood; but in the severe cases the blood always contains them. It is possible, however, that the micrococci find their way into the blood through the lymphatics, and they may not have time, therefore, to enter the blood before death ensues. This supposition is strengthened by the fact that they have been observed to appear in the blood some hours after death; but more direct evidence on this point is still wanting. Micrococci have been sought for in the blood of persons suffering from other diseases, but they have only been found by the authors in three cases, and even these may have been of a diphtheritic nature.

The third chapter treats of the pathology of diphtheria. It opens with a direct contradiction of the opinion quite generally held, that diphtheria and pseudo-membranous croup are distinct diseases, and the reasons for the position thus assumed are clearly stated.

The micrococci found in the diphtheritic false membrane are always of two sizes, probably representing different stages of development. The smaller usually infest the leucocytes, while the others form zoöglœa-masses, infesting or destroying the epithelial cells. The number of mi-

crococci was always proportionate to the intensity and stage of the disease. Rod-bacteria, which have been described by other authors as associated with this disease, probably do not appear until the membrane begins to putrify.

The larger micrococci range in size from $\frac{1}{8000}$ to $\frac{1}{1400}$ of an inch in diameter. In culture experiments, the smaller ones, which infest the leucocytes, after a period of active movement, soon become still, and the corpuscles burst, allowing the enclosed contents to escape as a zoöglœa-mass of micrococci, each of which measures about $\frac{1}{20000}$ of an inch. After twenty-four hours the individual micrococci are set free. These soon begin to multiply by division, which may be continued for five generations, but after that the multiplication is much less rapid. A temperature of 37° to 40° C., is most favorable for their multiplication, but at 70° C., they do not lose their vitality.

Some inoculation experiments with rabbits, material from the mild form of the disease being used, frequently led to a secondary form of tuberculosis, but very rarely to a form of diphtheria. When the poison from the more malignant type was used, however, the results were quite different, although not conclusive in proving that the disease thus engendered in rabbits is true diphtheria.

As a result of many experiments, it was concluded: "That both septic animal matter and non-organic irritants placed in the trachea cause pseudo-membranous trachitis which we have failed to distinguish from diphtheritic trachitis, the membrane in both cases containing micrococci.

We cannot do full justice to this valuable report in the short space at our disposal, but we have endeavored to give a fair outline of the work recorded, so that those who are interested in the subject may form some idea of the results attained. There is much that still remains to be done before the subject is fully elucidated, and we trust the National Board of Health will encourage the prosecution of the work.

—o—

Tuberculosis.—M. Toussaint recently made some remarks upon tuberculosis, at the French Academy of Sciences, which are of interest in connection with the preceding article. While admitting that lesions can be produced at will resembling tuberculosis, by inoculation with inert substances, M. Toussaint asserts that the disease thus engendered is not a true tuberculosis, and the seemingly tuberculous matter obtained from it does not reproduce the disease by inoculation. The histological appearances supposed to be characteristic of this disease are, therefore, fallacious.

True tuberculous matter can reproduce itself indefinitely, and the more often it is inoculated the more virulent it becomes.

—o—

Bulletin of the Museum of Comparative Zoölogy.—This publication, from Harvard College, deserves to be ranked as one of the most valuable scientific publications of the country. The importance to the zoölogist of the articles that have been published during the last two years or more, relating to the dredgings under the direction of Prof. Alexander Agassiz, cannot be overestimated. That we have not mentioned the results more frequently in these columns, is owing to the nature of the contributions which are only valuable in their complete form as published—not from any want of appreciation of their value on our part.

We have before us a volume of 625 pages and five large lithographic plates, entirely taken up with a contribution from E. L. Mark, on the "Maturation, Fecundation and Segmentation of Limax Campestris." We began to read this with the intention of giving a synopsis of the work, but it was too great a task. The monograph is one of the greatest interest, and it is so clearly written that we

recommend its careful study by those who desire to obtain an insight into the methods and results of embryological study.

Numbers 1–5 of volume IX of the *Bulletin* comprise several reports of the dredging under the supervision of Prof. Agassiz in the Gulf of Mexico. Among these are found a description of new species of *Asterias* by Prof. E. Perrier; a preliminary report on the Mollusca, by W. H. Dall, and a very interesting letter from Prof. Agassiz on the distribution of living forms about Key West and the Tortugas.

——o——

Nuclei and their Structure.—In *Zoologischer Anzeiger* Prof. Balbiani describes some curious structures in the nuclei of the salivary cells of the larva of *Chironomus plumosus* which correspond with similar structures observed by him in the nuclei of certain other cells. In the large nuclei of the cells he describes two large nucleoli with vacuoles, and besides these a pale body, having the form of a cylindrical cordon variously twisted upon itself like an intestine. It has a diameter about 0.015 mm. Usually it is free in the cavity of the nucleus, but in old larvæ it is often broken into fragments, which may be either free within tbe nucleus or fixed by one extremity to the envelope of the nucleus. When the cordon is continuous, each of its extremities ends in one of the nucleoli. Its substance is not homogeneous, but exhibits transversal striation as though made up of alternate discs of clear and less transparent material. It is said that these structures can be readily seen in the fresh cells, and, so far as we can learn, without chemical treatment.

Prof. Balbiani describes the action of certain re-agents upon the cells.

The structure described seems so remarkable that we would like to learn whether others can verify the observations of Prof. Balbiani.

——o——

The Microscope.—As we are not slow to condemn what seems unworthy, we are more ready to commend what is good. We are, therefore, pleased to notice the greatly improved character of Prof. Stowell's journal, *The Microscope*, as revealed in the February number. In it we find nothing to condemn, and we trust this may always be the case in future. May we not take some credit to ourselves for this improvement?

NOTES.

—The office of the *Scientific American* was destroyed by fire on the morning of January 31st. Within two hours after the fire, new and commodious offices were leased, not far from the old place, and the business of the publishers has suffered but little interruption. Such promptness and enterprise deserves commendation.

—We are indebted to Messrs. J. W. Queen & Co. for two very excellent microphotographs which, we believe, were made expressly for them. One is of the late President Garfield, and the other of Mr and Mrs. Garfield. The original of the former is by Sarony, the others were taken by J. F. Ryder & W. J. Baker, of Columbus. The price of these slides is 60 cents cach.

—The eighth part of the *Micrographic Dictionary* is now in the hands of subscribers. The last subject treated is "Cyclops," and about one-third of the work is now issued. The numbers have been issued with great regularity, and they are fully up to the standard of excellence desirable in such a work. All the new plates are valuable and accurate. Our subscription list is already longer than we expected it would be, and we are glad to notice this as an indication of the increasing interest in general microscopy in this country.

—We are pleased to notice that Dr. J. W. S. Arnold has offered his services to microscopists who desire photographs of microscopical preparations. We have frequently been asked where such work could be done, but have never been able to give the desired information. Now, however, those that cannot draw well, can have their specimens photographed, and thus prepare illustrated articles for publication, or for other purposes.

MICROSCOPICAL SOCIETIES

There seems to be very little activity among the microscopical societies of the country, judging from the small number of reports of meetings that come to us, and the dearth of interesting matter in most of those that do come. We are forced to the conclusion that either the societies are doing very little or else they have very inefficient secretaries. What has become, for instance, of the San Francisco Society which, at one time, was one of the most active, owing to the energy of some of its members? Is that society dying out, as many others have in the past? We might ask the same question concerning several others, but this being the most prominent, will justify our assertion that there is a falling off of interest in society meetings.

However, there are several societies that have been, and still are doing very excellent work. Among these are the Elmira, the Illinois State, and a few others. The NEW YORK Society is slowly making its way to the position it should hold, as the leading society in the country.

At the meeting of that society held February 17th, a number of interesting objects were shown. The President, Mr. Braman, showed a specimen of Gordius, the hair-worm, about three inches in length. Mr. Dinwiddie remarked that he had observed the eggs deposited in chains, Mr. Hitchcok called attention to the periodicity which characterized the appearance of the filarian worms in the blood of persons suffering from disease.

As it is expected that a more full account of this worm will be given at a future meeting, we postpone further notice until that time.

Mr. Shultz exhibited a good specimen or *Eozoon Canadense*, the remains of what is supposed to be the oldest form of life upon the globe.

Mr. F. W. Devoe showed a very beautiful object, which was also a new one to most of the members. A common newt was placed in a suitable holder, so as to expose the under part of the body. A strong light was thrown upon it and the circulation of the blood was thus most beautifully shown. It should be understood that the illumination was from above—the newt was examined as an opaque object.

Mr. W. H. Mead showed the lines on *Amphipleura pellucida* with a Zeiss homogeneous $\frac{1}{18}$-inch, belonging to Mr. Hitchcock.

At the last meeting, held March 3d, Mr. J. D. Hyatt gave an interesting account of his observations on the boring sponge, which will be printed in full in our next number. He presented strong evidence that the sponge makes the burrows in which it is found. His conclusions were based upon the study of living specimens. The subject was illustrated by specimens of marble and oyster shells, which had been penetrated by the sponge.

Remarks were made by several members, and by Prof. D. S. Martin.

Mr. Hitchcock described a new device for a vertical illuminator.

Mr. Hyatt exhibited a section of a "nummulitic flint," and sections of flint showing a hexagonal structure, which he thought was due to a fossil coral.

Some beautiful objects were shown by Mr. Mead, Mr. Devoe and Mr. Van Brunt, for the comparison of some 1-inch objectives by different makers.

Mr. Kunz spoke of the use of cinnamon oil for the examination of rough minerals. By applying a few drops of oil to the surface of a transparent mineral it is possible to examine the interior for inclusions, flaws, etc., without grinding the surface flat. Sand can thus be examined for inclusions under the microscope.

Six new microscopes which a special committee, appointed at the last meeting, had purchased for the Society, were used for the first time. Mr. Van Brunt presented three student lamps.

At the next meeting Mr. Hyatt will speak of some points in the structure of the boring anelid.

At the last meeting of the CAMDEN Society, the different methods of drawing microscopic objects were illustrated, and discussed at considerable length. Mr. Morrison showed an arrangement, on the plan of a camera obscura, by which the image was thrown upwards upon a piece of transparent paper placed upon a plate of plain glass. It could then be traced without the fatigue to the eyes which attends the use of the camera lucida. Mr. Kain showed a method of throwing the image downward by means of a convex mirror, and receiving the magnified image upon a sheet of white paper placed upon the table. It could then be traced without difficulty.

The officers for the present year are as follows: President, A. P. Brown; Secretary, C. Henry Kain; Treasurer, L. T. De Rousse: Curator. J. P. R. Carney; Managers, H. S. Fortiner; Charles Bowden, Robert Patterson.

NOTICES OF BOOKS.

Practical Microscopy.—By Geo. E. Davis, F. R. M. S., F. I. C., F. C. S., etc., London. David Bogue, 1882. (Cloth, pp. 335. 357 Illustrations. $3.00).

Recognizing the need of a book of a practical nature for beginners in microscopy, the author has endeavored to adapt this volume to their wants.

The first chapters are devoted to general statements of the principles upon which microscopes are made, and also short descriptions of the principal stands of English makers, with profuse illustrations. Though mentioning some of the better-known American manufacturers, the author does not describe any of their instruments, with a single exception, and seems not to be acquainted with the various American stands of the higher grade, for he makes the rather remarkable statement that the difference in cost of the English and American stands is due to the superior workmanship of the former.

The preceding chapters are devoted to short, but very concise descriptions of the various accessories and instructions for their use. Throughout the book the author lays great stress upon the comparative value of the various accessories and materials for work, advising the student not to encumber himself with a host of expensive accessories which, though useful to the expert and professional man for saving time and labor, are of comparatively little value to the student, and always in his way.

Chapter V is devoted to general remarks upon objectives; defining very explicitly the terms "working-distance," "defining power," "flatness of field, and freedom from distortion" "penetrating and resolving power." Numerous tables and diagrams, and illustrations of test-objects are given. The difference between low and wide-angled, and dry and immersion objectives is also explained and the relative value of each discussed.

Under the head of "Collection of Objects," the various modes of collecting, and the implements used, are described.

Considerable space is devoted to dissections and section-cutting, giving many formulæ for preparing objects, and the mode of procedure, together with a description of the various instruments employed.

Micrometry and photo-micrography are concisely described, and the instructions for photographing with complete formulæ for the preparation and development of plates are worthy of careful attention.

The micro-spectroscope is explained, and figures of ten spectra are given.

The processes of staining, injecting and mounting are described at considerable length.

The indexs is very full and complete, occupying eleven pages.

It is a book which we can recommend to all who desire to make themselves familiar with the microscope, and is written in a very readable and interesting style.

H. H.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Unmounted Foraminifera from the north of Ireland for mounted objects. T. B.]ENNINGS,
Signal Office, Springfield, Ills.

Diatoms, recent, fossil and *in situ*; algæ, ferns, and much other first-class material to exchange for first-class material of any kind, prepared material, and particularly foreign diatoms, recent and fossil preferred. M. A. BOOTH, Longmeadow, Mass.

Having secured a supply of the microphotographic films used for transmitting news by pigeon-post during the siege of Paris, I will take pleasure in sending an unmounted specimen, suitable for microscopic use, to any person who will send me a stamped and directed envelope for that purpose. R. H. WARD, M. D.,
53 Fourth Street, Troy, N. Y.

Well-mounted slides of Pathological and Histological specimens, injected and otherwise, in exchange for Insects, Polariscopic or Pathological slides.
FRANK P. HUDNUT, Orange, N. J.

A slide of well-cleaned *Epithemia turgida* offered for any other well-mounted object or material.
H. S. WOODMAN, P. O. Box 87,
Brooklyn, E. D., New York.

A beautiful collection of wild seeds of Central Ohio to exchange. List furnished on application.
F. O. JACOBS, Newark, Ohio.

Well mounted Diatoms, etc., in exchange for first-class slides, or material. W. H. TIVY,
6th and Olive Streets, St. Louis, Mo.

Well mounted Diatoms on Alga, Polycistina, Zoophytes various, and other miscellaneous objects for other well mounted objects. Mounted Insects or parts of Insects preferred. W. FARNELL,
125 Walnut Street, Macon, Ga.

For a packet of frustules of *Biddulphia lævis*, send slide, or unmounted specimen to
K. M. CUNNINGHAM,
Box 874, Mobile, Ala.

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Home-made Apparatus for Collecting.

As the collecting season once more draws near, the description of a very convenient bottle-holder which I devised and used last season, may not come amiss. Select an ordinary gimlet-pointed wood-screw of the proper size, flatten the head—or have the blacksmith do it for you—then cut a narrow strip of sheet-brass, bend it round the bottle you intend to use, turn the ends at right-angles to the ring and let them project about ⅜ of an inch, place the flat head of the screw between them, and fasten all together with a copper-rivet. You then have an instrument somewhat resembling a pocket cork-screw that can be readily attached to an ordinary cane, or any convenient stick (fig. 22), first winding

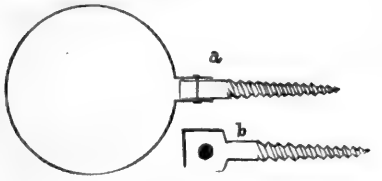

FIG. 22.

the stick for a short distance with strong twine to prevent splitting. A ring for a net, hook-knife, or a spoon can also be made in a similar way.

I also find an ordinary gimlet-pointed closet-hook screwed into a stick, very handy for securing plants floating in the water.

E. L. CHEESEMAN.

KOWLESVILLE, N. Y.

——o——

Telescopic Field and Microscopic Aperture.

BY HON. J. D. COX, F. R. M. S.

The discussion of the question of angular aperture has resulted in a general agreement among scientific men that apertures in excess of the maximum for dry glasses, are both practicable and useful; and there is a strong tendency to accept Professor Abbe's numerical aperture as a convenient standard by which to express the comparative apertures of all objectives, because it reduces them to a common measure of the number of rays which may pass from the illuminated object in front of the lens, to the image at the aplanatic focus behind it.

Accepting these results, there still remains the question: What is the correct method of measuring this aperture? From a former generation of microscopists we have inherited the habit of measuring the angular aperture of the microscope by an angle of which the apex is the centre of the microscopic field of view, and whose sides bound the telescopic field of view when the microscope is turned into a telescope, either by removing the ocular and looking down the tube with the naked eye, or by substituting a terrestrial eye-piece in its place.

The old sector table is the basis of measurement for all the apertometers in use, and the principal modification since made, consists in the addition of a semicircular disc of crown-glass, or a hemisperical traverse lens, by which the angle of aperture in glass, or in a homogeneous-immersion medium, may be directly measured. It

is usual to direct that the objective shall be focussed upon an object at the centre of the disk or traverse lens, so that the sides of the angle, including the telescopic field, may be radii from the optical centre of the apparatus. The chief purpose of this article is to show some reasons, based upon experiment and upon the common principles of geometric optics, for thinking that the telescopic aperture, however correctly measured, is not the microscopic aperture. In other words, the telescope and the microscope, though having most of the lenses in common, are not the same instrument, and have not the same angle of aperture.

In objectives of high power and of very short working-distance, the difference referred to is so small that it may be practically neglected; but with low powers it is large enough to detract from the usefulness of the common methods of measurement, and if the graduated glass disc or traverse lens is used with a terrestrial eye-piece, in the manner above referred to, even absurd results may be reached.

In the discussion of the methods of measuring the angle of aperture, attention was naturally fixed upon glasses of high power and wide angle, because the controversy centered about the possibility of increasing the aperture beyond the maximum in air. From time to time, however, complaints were made by one and another that the measurement of low-power glasses was unsatisfactory, and that different apertometers gave very different results. All sorts of reasons were given for accepting the new and rejecting the old methods. The use of slits and stops to shut off extra rays, supposed not to be "image-making," the determination of the "available front" of the objective, the necessity for a stop or diaphragm behind an objective used in the draw-tube to make a terrestrial eye-piece—these and other problems have been examined and discussed; but the examination of the microscopic field itself, and the conditions of use of the microscope when used as such, seem to have been neglected.

The natural reason for such neglect is found in the fact that the measurement of the telescopic field is easy for all lenses, whilst only the lowest powers can be conveniently examined in an analogous way, for the purpose of determining the relation of microscopic field to angle. The results I shall here state are the outcome of a determination to see what these low-power lenses can tell us upon this subject. It appears, as is usual in such cases, that actual experiment drew attention to some very simple applications of familiar principles, which seemed to have been overlooked in the discussion.

Among these, as preliminary, I will state two. The first is the principle applying to conjugate foci, and no better form can be given it than that which Professor Abbe has used in his article on the apertometer. "Let L "be any system of lenses which takes "in and transmits rays from different "objects, and O, O', two limited areas "in planes perpendicular to the axis, "situated at conjugate points of the "axis and conjugate one to another "as to their linear extension, then "all the rays entering the system L "through the area O will leave the "system through the area O'; and "no single ray can emerge from L "through the area O' which has "not entered L through the area O "from whatever object the rays con-"sidered may start or toward what-"ever points they may proceed."* The second is enunciated in most of the elementary treatises on optics, and is the simple proposition that in order to form an image behind a lens, a luminous object of appreciable size is not placed in the principal focus of the lens, but some distance further from its front.

* *Journal Royal Micros. Soc.*, 1880, Part I, p. 20.

Let us now look for a moment at the difference between the telescopic and microscopic fields and at the different ways of regarding them. Let $l\,l'$, in fig. 23, be a lens through which the rays from a microscopic object ($a\ b$) form an image of this object ($a'\ b'$) at the conjugate aplanatic focus. This enlarged image is, of course, examined by means of the microscope eye-piece. But remove the ocular and apply the naked eye to a small hole at o' (or substitute a telescope eye-piece) and we see, not $a\ b$, but objects remote and in the telescopic field $c\ d$, by means of the image of that field which is formed behind the objective, but quite close to it, and at the aplanatic conjugate focus of $c\ d$, viz. $c'\ d'$. This image is a real image, and its size and distance from the back of the lens depend upon the distance of $c\ d$ from the front of the lens, but it is bounded, nevertheless, by the marginal rays of the cone $l\,o'\,l'$. It will, in fact, be found where the rays $c\ l$ and $d\ l'$ cut $l\ o'$ and $l'\ o'$ after refraction. This follows strictly from the principle of conjugate foci already stated, and if o be coincident with the centre of the disc of the apertometer, or with the pivot of the swinging arm connected with the traverse lens, the angle $c\ o\ d$ will generally be correctly measured by the degrees upon the sector between c and d. It is also evident that as o' approaches the lens, as when the tube is shortened, its conjugate focus o recedes from it and the angle $c\ o\ d$ becomes smaller. Leaving out of consideration, for the present, any other cause of variation, it is clear that the angle of the telescopic field diminishes with the shortening of the tube.

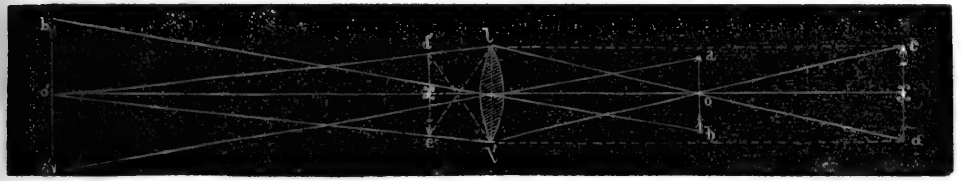

FIG. 23.

Another fact is also important. Viewed with reference to the image $c'\ d'$, the ray $c\ o\ l'$, is marginal to the cone $l\,c\,l'$ and the ray $d\,o\,l$ is marginal to the cone $l\,d\,l'$. A pin-hole diaphragm at o, only large enough to allow a minute pencil of rays to pass from c and d respectively, will still suffice for the formation of the image $c'\ d'$; but if farther from the lens than o, the field will be rapidly cut down and the apparent angle diminished, for no ray from c or d can reach the lens through the diaphragm after the latter has passed beyond the intersection of $c\ l'$ and $d\ l$. The limitations under which this will be found true, in practice, will be examined hereafter; it is now referred to for the purpose of emphasizing the fact, that the angle of aperture of the instrument when used as a telescope, is measured by the rays passing from the margin of the field $c\ d$, through o, to the margin of the available front of the lens, and thence to the margin of the image $c'\ d'$. Starting from the image, under

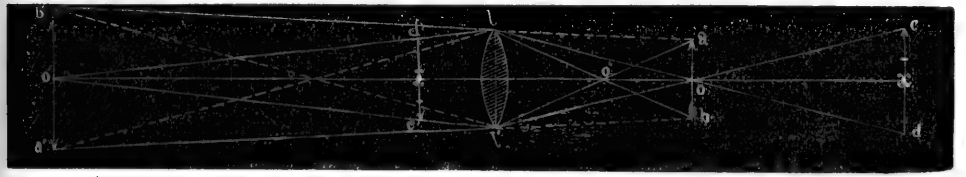

FIG. 24.

the law of conjugate foci this fact may be stated thus: the angle of aperture is the angle at the principal focus for the divergent rays from the image *c' d'*, incident upon the lens *l l'* and refracted to *o*. I do not doubt that this is a proper mode of determining that angle in all objectives which form the telescopic image behind the back-lens. It shows the varying size of the field under varying lengths of tube, and marks the only significant phenomena which can properly be called the aperture of the telescopic instrument. It does this by the examination of the image itself, so that there is no question as to what are image-forming rays.

It seems to me that the same method should be applied to the instrument used as a microscope. But it then produces different results.

The relation of the image to the object is the same in the microscope as in the telescope. They stand to each other in exactly the relation of the "two limited areas in plains perpendicular to the axis," at conjugate points upon it, as stated in the proposition already quoted. In both cases the examination of the image may be made by a properly constructed eyepiece, or by the naked eye; for though the microscope, as constructed, is not well adapted to the latter mode of viewing the image, there is no serious difficulty in adapting it to that method. In the one case we have a comparatively small image of a large, distant object; in the other we have a large image of a small, but near object. In one case the image is comparatively near the back of the lens, in the other it is distant from it. It is evident that these variations of condition do not affect any principle, and that the rays which determine the angle of the field in the one case, must be exactly homologous to those which determine it in the other.

As we have already seen in the case of the telescopic image, the rays which determine the aperture are those proceeding from the extremities of the image *c' d'* and by refraction by the lens are made to cross at *o* and reach the extremities of the object at *c d*. Trace the homologous rays from *a' b'* fig. 24, the microscopic image, and we find that they pass the lens and cross at *o''* reaching the extremities of the object *a b*. If the former is the measure of the aperture of the telescope, the latter is that of the microscope. In both cases they are the limitation of the field by the rays crossing at the principal focus for rays having the divergence or convergence of *c' l'* and *d' l'* and *d' l* in the one case, and of *a' l'* and *b' l* in the other.

The crossing of the telescopic rays at *o* in the centre of the microscopic field, is due to the fact that *o'*, taken as the point of view, is in the centre of the microscopic image *a' b'*, and as *a b* is the conjugate of *a' b'*, *o* must also be that of *o'*. It thus affords an easy way of measuring the telescopic angle of field, or of aperture; but that this is in any proper sense the measure of the microscopic angle is questionable. To apply the method to the microscope, the natural way would seem to be to place a minute hole in a stop at *o''*, and, by some proper device, to bring this point over the axis of motion or the optical centre of the apparatus. The distance from *o* to *o''* would then be the distance of the object from the principal focus for rays of the convergence *a' l'* and *b' l*, according to the second proposition laid down at the beginning; and the angle thus measured is the angle made at the principal focus by rays of the given convergence on the other side of the lens. If there be any significant angle in optics, it would seem to be this, and it would seem also to be the true angle of aperture of the lens, if the term has any definite meaning.

The results of the practical experiments with such a pin-hole diaphragm will be given presently; but I must call attention to the theoretical difference between the telescopic and

microscopic angles, in the example given.

First.—The telescopic angle at o is less than the microscopic angle at o''. This results from the primary laws of refraction, but is also clear from inspection. The measure of the telescopic angle is not, therefore, the measure of the microscopic angle.

Second.—The telescopic angle at o diminishes with the shortening of the tube; that is to say, by the approximation of the point o' to the lens and the consequent increase of the distance between the lens and the conjugate point o. But by the shortening of the tube when using the instrument as a microscope, the field in the image $a'\ b'$ remains of the same size, being determined by the field-glass of the ocular, and the rays $l\ b'$ and $l'\ a'$ become more convergent. They will, therefore, cut the axis nearer the front of the lens, and the angle at o'' will grow wider as the tube is shortened. Thus the effect of shortening the tube is just the opposite in the telescope from what it is in the microscope.

There are reasons, growing out of the construction of the instrument, which prevent the angle at o'' from increasing sensibly when the tube of the microscope is shortened. These will be noticed hereafter, but in no case can the angle at o'' vary in the same manner as that at o. The measure of the one, therefore, can never be the true measure of the other.

Some interesting facts observed in the practical application of the foregoing principles are worthy of notice. The application was made to four low-power lenses, viz.: a three-inch, an inch-and-a half, and a three-quarter-inch, all double system objectives, and a one-inch of a "student" series having only one achromatic lens. A wooden slide with a large hole, had the top covered with thin, black paper, in which a pin-hole was made .0125 (or a little more than a hundredth of an inch) in diameter. To get rid of the burr around the edge of the hole punched with a needle, a little dark-colored wax was melted upon it, rubbed down thin, and the hole was then made smooth and neat with the needle heated. This slide was placed upon the stage in the usual way and a micrometer-scale was fixed to the substage to serve as an object. I soon found, however, that there was no need of the graduated scale upon the substage, but a bit of white cardboard there gave the best light for the examination of the field—much better, and more free from glare, than the illumination from the mirror. The purpose in using the paper stop and slide rather than a blackened glass slide with a slit, was to avoid any refraction in the glass and to make the diaphragm opening circular. In the manner stated, I interposed a diaphragm in mid-air between the objective and the object, and the intent of the experiment was to measure the angle of aperture of the microscope at the principal focus o''.

I first measured the actual field of the objective with the stage-micrometer, using the ten-inch tube and the *A*-ocular, of which the field-glass is slightly over 1.1-inch in diameter. The working-distance from the top of the slide to the front of the objective was also measured very carefully with dividers. A vernier upon the body of the instrument would have been useful for this purpose. The paper diaphragm was then placed upon the stage instead of the micrometer, and the hole brought to the centre of the field. The tube was next racked down until the apparent enlargement of the hole was equal to the field, as was shown by the round and well defined margin of the mounting of the ocular. If a piece of dark cloth was laid over the stage and tube, as the photographer shields his camera, the growing size of the circle of light was very easily observed. Removing the diapraghm-slide, but leaving the tube in position, the substage was then racked up till the divided scale upon it was in focus.

Now, replacing the diaphragm, and looking through the tube, the entire field was visible through the hole, of the exact diameter it had when measured in the ordinary way upon the stage. The distance from the top of the diaphragm to the front of the objective was measured, and subtracted from the working-distance, giving the distance of the object at *o* from the principal focus *o''*, and this with the diameter of the field enabled me to construct and measure the angle *a o'' b* and its equivalent *l o'' l'* (fig. 24).

The draw-tube was then closed, making a tube of about 5½ inches, and the same series of measurements was made as before. Afer a number of experiments, it became apparent that the uniformity of the size of the field when seen through the diaphragm and without it, was such that this test need not be repeated, the full illumination of the field-glass of the ocular being entirely reliable evidence that the pin-hole coincides with *o''*. The substage and the card-board, or a white disc over the plane mirror, being still useful as giving the white-cloud illumination.

The following table gives the measurements which were made:*

Objectives.	Long tube.			Short tube.		
	Field.	Work. dist.	*o o''*	Field.	Work. dist.	*o o''*
3-inch..	0.29	1.55	.90	.52	1.95	1.53
1½ " ..	0.16	.87	.28	.29	.98	.515
¾ " ..	0.108	.26	.15	.172	.32	.245
1 " ..	0.13	.97	.33	.195	1.05	.50

Upon constructing the figures indicated by these measurements, one of the first things that will be noticed, is the fact that the principal focus approaches the front of the objective when the tube is shortened, but without changing the angle appreciably (see fig. 25). It is as if the angle were moved toward the objective, its sides including a smaller circle on the front of the lens. That this is in no proper sense a reduction of "available front" will be seen hereafter.

It might, at first sight, appear that this retraction of the principal focus was due to the combination of two systems in the objective; but it will be seen that it occurs in the single lens of the one-inch objective as well as in the two-system glasses, though not

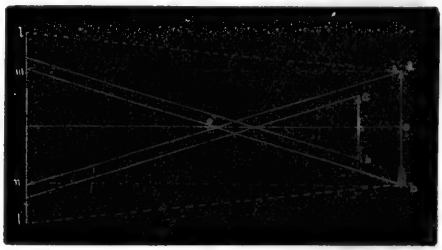

FIG. 25

to the same extent. It is probably the effect, in the main, of the diaphragm behind the objective, or of the brass mounting of the lens which acts as a diaphragm by interposing between the margin of the back lens of the objective and the edge of the field-glass of the ocular. This, however, deserves a separate investigation, and it is enough to say that the practical result in the lenses measured, was a noteworthy constancy of angle at the principal focus, so that it could be treated as unchanging. Fig. 3 is a protraction of the angles and their relative position in the case of the inch-and-a-half, and it is a fair sample of the result of the other cases.

The following table gives the comparison of the angles at the telescopic principal focus, and the microscopic, for both long and short tubes :—

Objectives.	Telescopic P. F.		Microscopic.	
	Long tube.	Short tube.	Long tube.	Short tube.
3-inch..	15°	13½°	18°	19°
1½ " ..	26°	23½°	30°	30°
¾ " ..	38°	36°	39½°	39½°
1 " ..	13°	12½°	21°	21½°

In the case of the three-inch objective four separate measurements of field, working-distance, etc., were made with four different lengths of tube, and the results confirmed in the most striking manner the general con-

* In transferring the measurements from the dividers. I found a loose vernier very useful. It consists of a bit of ivory on which .9-inch being subdivided into ten parts, this scale may be applied to the ordinary scale divided to tenths, so that hundredths are read off at once. It can often be used when a diagonal scale could not.

stancy of the angle at the principal focus of the instrument used as a microscope. The significance of this angle, and its importance, is therefore partly found in the fact that it is the angle within which the actual field of view enlarges as the tube of the instrument is shortened, and working-distance is increased.

The differences between the angles of the telescope and that of the microscope are seen in the above table. The approximate coincidence in the two, in the case of the ¾-inch objective when used with the long tube, shows that the different use may have different conditions, producing special variations. In that case, the so-called "available" front was so much less with the instrument used as a microscope, that the angle at the nearer focus was nearly the same as that at the further one.

It is, of course, apparent that all the above tables and measurements could be made much more exact by computation, if we were in possession of the full formulæ for the construction of the objectives in question, but in the absence of such knowledge, the experiments seem sufficient to illustrate the principles.

These observations suggested another series which is their natural complement, viz.: the investigation of the practical effect of stops placed upon the front of the objective. For this purpose, circular discs of black paper were used, beginning with those of the size of the so-called "available" field in the cases before described, and enlarging them till the whole field of view of the microscope was stopped out. This was only done when using the instrument microscopically, for the results would be similar in kind in either case, and my purpose was to see how much of the front in the glasses named is useful by contributing image-making rays which go to the completion of the definition, brilliancy, and perfection of the total image examined in the ocular.

In the case of the three-inch objective, I began with a stop .3-inch in diameter. With the long tube, the only difference noticed was a slight lack of good definition in the centre of the field. Second, a stop of .35-inch was used. A small round shadow was now visible in the centre of the field, almost a black dot in its centre, and shading gradually away. Its effect as shadow was seen on about one-sixth the diameter of the field, rather less than more, and the divisions of an ivory scale could be read through it, quite to the centre of the field. Third: A stop .42-inch was used. The diameter of the lens clear of the brass mounting, was carefully measured and found to be .46, so that the annular rim of the lens only .02-inch wide was in use. There was now a black spot in the centre of the field, stopping out rather less than one-quarter in diameter of the whole, shading away with a penumbrous margin. The fibres of paper, or the divisions of the ivory scale were plainly visible except in the central quarter of the field, but the definition was a good deal impaired. The scale showed that the field was undiminished in diameter, and that the black dot occupied $\frac{7}{25}$ of the whole of it.

I now began shortening the tube, and a bluish shadow began to creep into the field from the margin, whilst the black dot in the centre of the field grew smaller. When the draw-tube was quite closed the central black spot was reduced to a mere point, evidently the apex of a conical shadow touching the centre of the field-glass of the ocular. The shadows at the margin had become denser until they stopped out all but the central third of the field, when the object was still visible.

Precisely similar phenomena were seen in experimenting with the other lenses. The clear front of the 1½-inch measured .45-inch. A stop .39-inch in diameter left a very narrow annulus at the margin of the field, in which the scale divisions were seen.

The large, clear marginal space caused a little glow of diffused light within the lens, so that as the draw-tube was closed a gauzy mist covered the clear part of the field.

The clear front of the ¾-inch objective measured .36-inch. A stop .3-inch in diameter allowed no part of the object to be seen, though light enough was admitted to define the margin of the field. Smaller stops allowed more and more of the object to be seen, and one of .2-inch only appeared as a very small, indefinite, black point in the centre, with the usual penumbra about it.

The following table gives the diameter of the portion of the front lens included by the angle at the principal focus, both of the telescope and the microscope, as well as the full size of the clear front of each:—

Objective.		Telescopic.		Microscopic.	
	Full front.	Long tube.	Short tube.	Long tube.	Short tube.
3-inch..	.46	.42	.44	.215	.14
1½ " ..	.45	.40	.40	.33	.26
¾ " ..	.36	.20	.28	.08	.05
1 " ..	.24	.24	.24	.24	.214

In comparing these figures it will be seen that in the case of the single lens one-inch objective, the "available" front is the whole front when used as a telescope, and as a microscope when used with the standard length of tube. It is cut down when the shortening of the tube makes the mounting of the lens act as a diaphragm and prevents the marginal rays from reaching the field-glass of the ocular.

It will also be noticed that in the two system glasses, the construction of the objective is such as to diminish this "available" front most in the widest angled glass, viz.: in the ¾-inch which has 38° angle by telescopic and 39½° by microscopic measurement, being what is properly considered a wide-angled glass for its power. In this case the full field of .36-inch is reduced to .20 in telescopic use, and even to .08 in the microscopic use. It would be a very great mistake, however, to suppose that the remainder of the front is not useful, for we have seen that a paper stop .30-inch in diameter was required to shut out the whole field. Referring to the figures 25 and 24, it will be seen that the whole cone of rays $m\ b\ l'$ contributes to make the image of the point b at its conjugate focus b', and of this cone the portion $m\ b\ n$ would only be one-quarter of $m\ b\ l$ when $m\ n$ is half of $m\ l$, for the circular areas will be to each other as the squares of the diameters. In using it as a microscope, therefore, nearly four times this so-called "available" field is useful in transmitting image-making pencils which go to perfect the image at the conjugate focus in the ocular, and nearly sixteen times if we reckon the the areas of sections of the cones of rays. In other words, the maker of the objective has combined his lenses so as to use, or make available, the whole front except the narrow annulus .03-inch in width at the very margin of the lens, or only one-twelfth of the whole. It should be further noticed that the difference between the true front and the so-called "available" is greatest in the widest angled glass and least in the narrowest. Consequently when compared with working-distance, a measurement of the angle at principal focus seems to make less of the front available than in inferior glasses, which is not true. Still another point of importance is that the shortening of the tube acts conversely in its effect upon this "available" front in the case of the two uses of the instrument. Used telescopically, the shortening of the tube in the two-system glasses enlarges this part of the front, whilst it is diminished in the microscopical use; and both these results are such as follow directly from the elementary principles referred to at the beginning.

These considerations may fairly be regarded as indicating: First, that the measurement of the telescopic angle of field is not the true measurement of the angular aperture of the microscope. Second, that in low-powers

the results of using the telescopic measure are so unsatisfactory as to be practically useless. Third, that the measure of the angular aperture of any objective is the angle at the principal focus for rays of the convergence within the tube for which the lens is corrected, keeping in view the fact that this principal focus is not at the object, but between it and the lens. Fourth, that this measurement should be taken also with a tube of the length, and ocular of the diameter, for which the objective was constructed.

If these conclusions are found to be sound, it will not be difficult to make the practical application. The angle of any objective may of course be easily computed by any one who has the formula on which it is made; but the microscopist will be satisfied with methods of measurement that are approximately true. If, in high powers the telescopic angle of field does not differ sensibly from the angle at the principal focus of the microscope, the common method may still be used. In low powers the experiments herein detailed show that by the aid of a common table of chords or of tangents, and a couple of simple measurements, the angle may be quickly determined. I will only add that whilst choosing to make use of the pin-hole diaphragm in the former of these experiments because the circular field gave a stricter application of theory, and there was then no refraction of rays between the object and the lens, yet the observations were repeated with a slit .0015-inch in width, and with the same results as above described. Even with the three-inch objective the whole field was illuminated and was of full-size, though the light was much reduced.

It may be worth while to recollect that in the method of measuring the angles of objectives used some years ago by Mr. Tolles, Dr. Woodward and others, rays from the lamp were thrown down the microscope tube, and their crossing at the principal focus was ocularly demonstrated and measured in a square of crown-glass with ground surfaces. This was in true accordance with the principles stated above; though, when parallel rays were used, the angle attributed to the objective was evidently less than if the rays of proper convergence (b' l and a' l' fig. 24) were used. The fact that this was a different method with different results from that in which the telescopic field is made the criterion of the angle, does not seem to have attracted attention. In the opinion of the writer, the facts which have been stated and the proper conclusions from them, only recall us to the original and elementary idea of the aperture of a single lens, namely, the angle formed at the principal focus by the emergent refracted rays which have passed the lens, the convergence or divergence of these rays, when incident upon the other side of the lens, being given. Each point in the object from a to b is the apex of a pencil of rays, all of different angles. In this infinity of pencils it would appear arbitrary to select one as of special significance. The boundary of the whole cone at the principal focus, however, is that which, from the beginning of optical investigation has been treated as one of the fundamental elements in the discussion of the properties of lenses.

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Microscopical Laboratories.

BY PROF. J. W. S. ARNOLD.

The articles in the February and March numbers of your valuable JOURNAL upon the subject of microscopical laboratories are of especial interest to me, as, for nearly fifteen years, I have been constantly teaching practical histology and allied subjects. It has been my fortune to come in contact with students of all ages, and from almost every part of the world. The young and the old, the uninitiated and the advanced student pursuing special investigation, have been under my care and supervision

in laboratories of several kinds, with arrangements widely different for light, using sunlight, the electric light and the common candle, working from early in the morning until late at night. With this somewhat unusual experience, it has seemed probable that perhaps I might add a few words of interest to those already spoken by the author of the papers above referred to, and also to your own most excellent ideas in the January number of the JOURNAL, upon small microscopes. I certainly agree to the proposition that a well-lighted room is an essential, but, provided the room be large enough for the working tables to be at some little distance from the windows, I do not consider that any special exposure is superior to another. Light coming from the side of the room is, of course, much better than from a skylight. (I worked for a long time in the room upon the top floor of the Bellevue Hospital old museum and post-mortem rooms, where the lighting was from windows mainly in the ceiling, and found it anything but pleasant.) My private and student's laboratories now in the Medical Department of the University of New York, both have almost a northern and western exposure; this I find very nice indeed. With the exception of the electric light, artificial light is, I am sure, most unsatisfactory for the study of tissues. Every one is familiar with the difference produced by lamplight in tissues stained with hæmatoxylin, and even carmine imbibitions are much altered when viewed by any other than daylight, while picric acid stainings can scarcely be seen at all except by daylight. The eye does suffer from constant work by artificial light; my own personal experience, and that of many of my friends and former pupils, will afford ample proof of this. Our student's laboratory in the University, built according to my own suggestions, has proved perfectly satisfactory after a number of years of daily work for nine months out of the twelve. We have accommodations for twenty-four men. The tables are about three feet square, and fastened to the floor. Two tables face each other, so that one Bunsen burner, fastened upon the line of junction of the tables, and one rack of reagents—staining fluids, etc.—serve the two tables very well indeed. A microscope is supplied to every table, and a drawer contains the little dishes for staining, needles, etc., for work.

The question now arises as to the relative merits of large and small microscopes. Any worker will surely agree to the superiority of the smaller and more simple instrument. I know, full well, that the dealer praises the large and showy microscope, and the novice is impressed by the fine effect of the shining brass. Not so, however, the thorough microscopist, for he has learned that an instrument which cannot be used comfortably in the vertical position, is a constant source of annoyance while studying fluids and semi-solid structures, on account of the motion produced by gravitation, and the stage becoming fouled. A simple, plain-stage is, for obvious reasons, most desirable, and even the sliding motion for coarse adjustment is preferred with us. For my own part, Mr. Editor, I agree with you that the large and cumbrous microscopes are not so desirable for any purpose as the smaller model. Any size of tube can be used, even upon a low stand, and even for the resolution of lined test-objects, the smaller model does all that the larger can. The large Zeiss stand is, to my mind, the most perfect instrument made for all purposes except, perhaps, photography (which requires special arrangements to obtain the finest effects), and this instrument enables the greatest amount of work to be done in the least time. In the laboratories of the Old World small models, and very plain ones, have been, and are still, used exclusively. I have often had students come into the laboratory and desire to use their own mi-

croscopes, many of which were the long-tubed, complicated models. Very soon, however, they would become disgusted with their own property, and discard the large instrument for the one furnished by the College. The objectives required are only two, I think, at least for the beginner; an one-inch, and an one-quarter or one-fifth inch. Only two oculars are necessary—one with a micrometer-scale. The higher powers are generally employed for the study of amœboid movements, or some special subject, and a collection of half a dozen immersion one-tenths, with perhaps one or two even higher, will suffice for twenty-four students. In like manner, two or three polariscopes and spectrum-oculars will be all that is needed by two dozen men. Perhaps each man should have a microtome, though free-hand cutting is often quicker and better. The freezing microtome, I am confident, has but a limited use, provided the tissue be properly hardened. There are many objections to the promiscuous use of the freezing microtome.

My own experience then, taken for what it is worth—no less, no more—convinces me that a simple microscope, and a comparatively few accessories, combined with a desire to learn, and plenty of material, produces the best results in a student's laboratory.

UNIVERSITY OF NEW YORK.

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Photo-micrography.

BY PROF. C. HENRY KAIN.

Photo-micrography, or the art of photographing large views of microscopic objects, is no new thing, but I doubt whether microscopists in general are fully aware of the extent to which the late improvements in dry-plate photography have simplified the work.

To the investigating microscopist, it is almost absolutely essential to be able to permanently preserve the results of his observations. This is usually done by the aid of the camera lucida, and the zealous worker will often sit for hours with his eye fixed at the instrument, laboriously striving to represent an object, and, if he is not well-skilled in the use of the pencil, his labor is frequently almost useless, so inaccurate is the result. By far the greater part of this kind of labor may be saved at an expense so trifling, and with results so satisfactory, that I think the time is at hand when every working microscopist will regard a dry-plate photographic outfit as a necessary part of his equipment.

The wet-plate process is cumbersome and not well adapted to the wants of the microscopist; but the dry-plates now in the market are admirable, not only for their great sensitiveness and beautiful results, but also for the ease with which they can be manipulated. They can be purchased so cheaply that it will scarcely pay the microscopist to prepare them himself. Some of the great advantages which they possess are the following:

1. They can be kept for any length of time and used as occasion requires.

2. If not convenient to develop the plate at the time the exposure is made, it can be put away and developed at leisure, even after an interval of weeks.

3. No dangerously poisonous chemicals are necessary in the developing process.

4. They are so sensitive that the light of an ordinary kerosene lamp (preferably a student lamp), is amply sufficient to photograph objects with all powers not higher than a half-inch objective. Indeed, I think it probable that a quarter-inch objective could be so used by properly arranging a system of condensers.

The apparatus which I use is a small camera about eight inches square, such as is furnished with the amateur photographic outfits now so popular. To use it for photo-micrography I simply substitute my micro-

scope for the ordinary camera-lens. In order to make a perfectly light-tight connection between the camera and the microscope, I fasten over the opening of the camera a sheet of thick rubber having a hole cut in it somewhat smaller than the body of the microscope. Then, when the body of the microscope is thrust through the opening, the rubber closes tightly around it and makes a perfect joining. The eye-piece can then be inserted from the inside of the camera, if desirable. In photographing without the eye-piece there is apt to be a bright spot in the centre of the field of view, due to irradiation from the interior of the body the microscope. The use of the eye-piece entirely obviates this difficulty, and, at the same time secures greater magnification; but, of course, the field is not so brilliantly lighted. If, however, it is desirable to dispense with the eye-piece, the bright spot can can be avoided by lining the interior of the tube with paper which has a dead-black surface.

As it is desirable that the object shall be as well illuminated as possible, it is best to take the light direct instead of reflecting it upon the object by means of the mirror. It is also best to use two condensers, a large one for collecting as many rays as possible and concentrating them upon a smaller condenser, which, in turn, concentrates them upon the object. An achromatic condenser may be advantageously substituted for the latter.

As some who desire to experiment in this line may desire a starting point as regards the matter of exposure, I would say that with the light of a student lamp, and using a single condenser, I have found that from 1½ to 2½ minutes with a 2-inch, 2½ to 5 with a 1-inch, and 4 to 7 minutes with a ½-inch objective, are about the proper times when the A eye-piece is in, and using what are known as Carbutt's rapid (B) plates, No. 468. When the eye-piece is not used about one-half of that time is required. Of course the time of exposure will vary somewhat, according to the density or transparency of the object, and, if stained, according to the character of the coloring matter.

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Apparent Motions of Objects.

BY PROF. F. C. VAN DYCK.

Objects viewed through the microscope seem to move when the position of the mirror is slightly changed.

This fact is doubtless familiar to most microscopists, but has not, so far as I know, been discussed in its optical bearings.

The phenomenon is easily observed by using nearly parallel rays to illuminate the object, and placing the mirror approximately central under the stage. If daylight is used, set the microscope at a considerable distance from the window, and use the plane-mirror. If lamplight is used, set the lamp at the focus of the concave mirror, or use a lens to make the rays parallel and reflect them from the plane-mirror.

If the object be so thin as to be sensibly in one plane, it will maintain its location in the field whatever change be made in the position of the mirror, so long as it is accurately focussed. But if the tube of the microscope be raised or lowered, so as to throw the object slightly out of focus, a shifting of the mirror on its bearings will cause an apparent motion of the object to one side or the other.

If an object of considerable thickness be used and the focus obtained for a central plane, rocking the mirror will cause the lower parts of the object to move to one side, while the upper parts move to the other side. I have an insect's foot with claws, which, treated in this way, seems to work the claws like scissors. Minute details of an object may be made to disappear under spots on the cover-glass, and various similar effects can be produced.

Let us suppose that the illumination is received from the left of the observer, and that a micrometer is inserted in the eye-piece to facilitate observation. Take three points, *A*, *B* and *C*, in the optical axis, *A*, beyond the focus of the objective, *B* at the focus, and *C* a little above the focal plane. Suppose a pencil sent from the mirror along the axis, passing *A*, *B* and *C*, and the centre of the objective. The images of *A*, *B* and *C* will fall with their centres on the axis. If the edge of the mirror toward the observer's right be tilted up, the point *A*, beyond the focus, will appear to be displaced toward the right of the field of view, the point *B* will remain stationary, and *C*, which is above the plane focussed upon, will move toward the left. Now it can be shown that if the spherical aberration of an objective could be corrected for a series of points and their images, all the images must remain stationary.

The necessity for correction consists essentially in the fact that the margins of lenses with spherical surfaces are too strong relatively to their centres. Hence, with an uncorrected lens, the image of the point *B*, made by the central portion of the lens, would fall on the axis; but an image of the same point, produced by rays entering the left-hand margin, would fall to the left of the axis, as well as nearer to the lens. The essence of correction is to relatively weaken the action of the margin, so that the image shall fall on the axis, and at the same distance from the lens as the image formed by its central portion.

Suppose this correction to be made for the point *B*. Let the mirror be tilted as described, so that a pencil of rays passes through *A* to the left margin of the objective. This pencil makes a smaller angle with the front surface than a pencil coming from *B* and entering at the same place. Hence, the pencil from *A* will reach the back surface of the lens at a point nearer the axis than would be reached by the pencil from *B*. If then the pencil from *B* comes to a focus on the axis, the pencil from *A* would cross the axis before coming to a focus. This explains the displacement of the image *a* to the right, under the conditions given above. The image *b* of the point *B* will not be affected, because the objective is corrected for a cone of rays from *B*, and any pencil passing through *B* must coincide with some element of the cone. It is not necessary to discuss the image *c*, for it will be seen that it must be formed on the side of the axis opposite to *a*.

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On a Convenient Method of Imbedding.

BY PROF. E. A. BIRGE.

The following method of imbedding was worked out by Dr. Justus Gaule, of the Physiological Institute, Leipzig, Saxony, by whom it was communicated to the writer. I have tried it on all sorts of tissue and can fully recommend it.

A piece of tissue of convenient size is to be taken, treated with the ordinary reagents and stained in the mass. If large, it may be convenient to remove it from the staining fluid to alcohol for a few hours and then replace it. When thoroughly stained, the specimen is to be put in seventy per cent. alcohol for about twelve hours, then transferred to absolute alcohol until it is completely dehydrated. Then put it in oil of cloves over night, or leave it there until it is convenient to imbed it.

Place it in turpentine half an hour, —large specimens for a longer time— then transfer it to a mixture of turpentine and paraffine, kept melted on a water-bath at about 40° C. In this the specimen, if from liver or intestine, etc., should remain for an hour or more; small nerves and blood-vessels of course need not remain so long. Then transfer it to a bath of pure paraffine, melted at a temperature

of 60° C, and leave it for the same length of time. Indeed, if care be taken that the temperature does not materially exceed 60°, the specimen may remain as long as convenient. When the tissue is thoroughly saturated with melted paraffine, a small paper box may be filled with melted paraffine and the specimen placed in it to cool. If properly imbedded, a cut surface has a smooth and shining appearance. No line of division must appear between the specimen and surrounding paraffine. The whole mass should cut, as nearly as possible, like one homogeneous mass of paraffine.

The subsequent handling of the sections varies with their nature. Moderately thick sections of firm tissue may be placed in turpentine to remove the paraffine and mounted as usual in chloroform-balsam. Thin specimens, or those which come to pieces when the paraffine is removed, like thin sections of liver, etc., may be laid on the slide on which they are to be mounted and the paraffine washed out by benzine, carefully applied with a dropping-tube; allow the benzine to evaporate, then lay on the cover-glass and apply thin chloroform-balsam at the edge of the cover. For exceedingly delicate specimens, such as embryos or osmic acid nerves, another method may be used. Lay the section on the slide, wet with absolute alcohol and let the alcohol completely evaporate, leaving the specimen attached to the slide; carefully heat until the paraffine is softened, or slightly melted. When cool, let a few drops of benzine—best applied with a brush—run over the section until most of the paraffine is gone. When dry, apply the cover-glass and put a thin solution of Canada-balsam in xylol to its edge. The xylol may be used instead of benzine but it is more expensive.

This method is very convenient, especially for histological laboratories. The specimen once imbedded, can be kept for years, and new sections cut as wanted. No change takes place in it nor can it dry up. It is suited to all tissues. I have imbedded all vertebrate soft tissues, chick and trout-embryos, hydras, snails, angle worms, clams, star-fishes, etc., with equal success in every case.

The ease with which the sections can be made, fully compensates for the time required to imbed. The merest tyro, provided with a good section-cutter, a brush to keep the sections from rolling, and such a specimen, must be a bungler indeed if he cannot cut at least thirty even sections from each millimetre of a moderate-sized specimen such as the œsophagus of a rabbit. With a little practice he should be able to cut a millimetre into one hundred sections without losing more than two. The writer has cut a frog's spinal cord so imbedded into 926 sections $\frac{1}{10}$ mm. thick in one day, and mounted them without losing any sections. No one who practises with these specimens will regard this as much of a feat. It is simply a hard day's work.

Specimens as large as the central hemisphere of a rabbit can be stained and imbedded whole.

I append my notes on the spinal cord of a frog, showing the times used in the various processes:—

Cord put into 3 per cent. nitric acid, two hours.

Seventy per cent. alcohol, six hours.

Stained in hæmatoxylin, four hours.

Seventy per cent. alcohol, over night.

Ninety-five per cent. alcohol, twenty-four hours.

Oil of cloves, twenty-four hours (did not wish to imbed till next day); then,

Turpentine stir half-an-hour.

Turpentine and paraffine, one hour.

Paraffine, one hour.

It should be remembered that these cords imbed easily.

One caution further—select paraffine if possible, which is bluish-transparent and which rings slightly when struck. The white, opaque sort is by no means as good. Any addition of

paraffine-oil, turpentine, etc., to soften the paraffine, renders it granular and brittle, and is decidedly injurious in its cutting qualities.

EDITORIAL.

Subscriptions.—Remittances for subscription should be made by post-office money-order, by drafts payable in New York, or in registered letters. Money sent in any other way will be at the sender's risk. A receipt will be immediately given for money received by open mail.

SYNOPSIS OF RHIZOPODS.—This book has been greatly improved by the addition of four lithograph plates, illustrating each genus of fresh-water rhizopods by at least one representative species. The price has, therefore, been raised to $1.00, instead of 75 cents as heretofore. Every species described by Prof. Leidy in his larger work is also concisely described in this book, and with the aid of the plates it is believed that species can be readily determined. Rhizopods are so abundant, that they have only to be looked for to be found, and they afford an inexhaustible source of pleasure to one who studies them with care.

—o—

MICROSCOPICAL LABORATORIES.—We are pleased to be able to publish this month a contribution from Dr. J. W. S. Arnold upon this subject. That it is from an experienced teacher, no one can doubt who will read the article carefully. We have nothing to add to what he has written, but we can say that the ideas expressed in that contribution are precisely those which we can most heartily commend to the attention of every teacher. Probably a wholly erroneous notion of the cost of fitting up a suitable microscopical laboratory has deterred many of our smaller medical colleges from teaching histology with the aid of microscopes; and it is a disgrace to the profession that so many hundreds of "full-fledged" physicians are graduated every year without having looked through a microscope.

Microscope-stands for laboratory use can be bought by colleges for about twenty or twenty-five dollars each, and the two necessary objectives, good enough ones too, need not cost over that amount, so that from forty to fifty dollars is enough to buy such microscopes as are required.

—o—

PHOTO-MICROGRAPHY.—The article we publish this month upon this subject, calls the attention of microscopists to the dry-plate process which is sure to give a great impetus to the photographic delineation of microscopic objects. The process is cleanly, and eminently well-suited to the wants of microscopists who cannot use the pencil well. Next month we intend to give another article on the subject, in which full instructions for using the dry-plate process will be found. It now remains for some enterprising manufacturer of photographic goods to introduce an apparatus for microscopical use, at a reasonable cost.

—o—

THE MICROSCOPE IN MEDICINE.—Perhaps it is not well to speak the truth too plainly, but sometimes it has a salutary effect. We have just alluded to the lamentable ignorance concerning the microscope among the graduates of medical colleges. If any argument were needed to convince the general reader of the want of interest in practical microcopy among physicians, we would only state that as a matter of business, we have found that it does not pay to send sample copies of this JOURNAL to the physicians in regular standing in State or County medical societies. On the other hand, it does pay to send them to the addresses given in general directories. We do not know how many physicians there are in the country, but if we had on our subscription-list even five per cent. of the total number, we venture to say our present list would be doubled. True, this is not a medical publication, but if the medical profession, as a whole,

had any appreciable interest in the microscope whatever, certainly more than five per cent. of its members would take a journal like this.

As a matter of fact, physicians in general are utterly incapable of using the microscope in their practice. They cannot tell uric acid from triple phosphates, tube-casts from cotton-fibres, cancerous from normal cells, or a starch-grain from a blood-corpuscle. Does this seem incredible? What shall be said of the physician who bought a fine immersion-lens and returned it as worthless, because he "immersed" it by filling the back with water and screwing it on the stand! Or of the other one who tried to examine a lump of coal with a $\frac{1}{12}$-inch!

A good story is told of the physician who showed what he vowed was a cancer-cell to a visitor, but the visitor failing to see the structure, required it to be particularly designated, when he found the supposed cancer-cell was a distorted air-bubble. Another physician found some tube-casts, which were mere scratches upon a slip of glass purposely made to test his knowledge. Another who had used a microscope for several years, had never heard of opaque illumination, and he examined everything, large or small, with a $\frac{1}{8}$ objective and a B ocular.

One of our prominent manufacturers of objectives once remarked that physicians judge of a microscope by its power, and therefore his mistake had been in making objectives of $\frac{1}{8}$-inch focus instead of $\frac{1}{6}$-inch. The meaning of this is simply that the higher power is the more saleable.

A little more knowledge of the microscope would prevent physicians from following too blindly, the teachings of incompetent and unscientific observers. We would hear less nonsense about new organisms found in the blood, and there would not be so many absurd observations published about disease-germs, extravagant assertions about the structure of protoplasm and about the diagnosis of the general constitution of a patient by the examination of the white blood-corpuscles. Perhaps the editors of many of our medical journals would do well to read up a little on the microscope—just enough to keep up the credit of their papers.

—o—

MICROSCOPIC ANGULAR APERTURE.—We desire to call particular attention to the article by the Hon. J. D. Cox, published this month, for we are sure that any one who reads it carefully will find it both interesting and instructive. Mr. Cox has explained several points in regard to the focus and the field of microscope objectives that doubtless have been very puzzling to some readers, with great clearness. We commend the article to every one who uses the microscope, whether interested in the subject of aperture or not, for it is a subject that should be more or less understood by every microscopist.

The article by Prof. Van Dyck will possess considerable interest, in that it clearly explains a phenomenon which must be familiar to every one who uses a microscope.

We reserve for next month an article by Mr. E. Gundlach, in which he endeavors to prove that immersion-condensers cannot be made, according to the present system, of sufficiently wide angular aperture to meet the requirements of the future, and describing a new form of condenser of larger aperture. Also another article, which was prepared for this number, defining the term "numerical aperture," and showing its relation to angular aperture.

—o—

SWARM-SPORES OF CLOSTERIUM.—Mr. William Trelease has called our attention to the probability that the phenomena described in the last number of the JOURNAL as the reproduction of *Closterium* by swarm-spores, is not a process of propagation, but that the moving spores, and the projections through the cell, belong to a parasitic plant, *Chytridium.*

Chytridium is a curious plant which attacks not only desmids, but other algæ, and also the saprolignieæ, but we have not been able to find a single species described as infesting *Closterium*, in any book in our possession.

—o—

COLLECTING.—During March, April and May, many of the algæ belonging to the family zygnemaceæ will be found in fruit when they are most valuable in collections. Vaucheria fruits early, and doubtless can now be found in good condition to study. Last month Mr. Wolle found new growths of *Chætophora*, *Ulothrix*, *Batrachospermum*, *Oscillaria*, and other algæ. At a meeting of the New York Microscopical Society, some newly hatched snails were shown, and the eggs should now be abundant on water plants, in almost every pond. Frog-spawn also must soon be found; and it is always interesting to watch the development of the tadpoles and their slow change into frogs, all of which can be followed in a jar of water. Euglenas, vorticellas, rotifers, water-bears, floscules, hydras, and a host of other specimens can be found in abundance this month. Mr. Balen's list gives the names of the species he has found quite lately.

For the novice in collecting we make a few suggestions. Look along the borders of ponds where weeds and grass are growing submerged. Pull out some of the stems that are covered with a light, flocculent deposit and examine them. Dip down into the bottom of the pond, and pull up whatever sticks and old tree branches, or plants, that may be caught. Look them over with a hand-lens for gelatinous masses and growing algæ, or whatever of interest they may have. For water-fleas, small entomostraca and water-insects, run a small hand net, made of common cloth, along near the bottom of the pond, and many can thus be caught. *Volvox*, which seems to appear at all seasons, can also be collected in such a net, which need not be more than three inches in diameter.

—o—

RULED LINES AS TESTS.—Last month we made some allusions to test-plates of ruled bands, and promised a few words more in this number. With reference to the plate ruled by Prof. Rogers, we have since obtained from him the estimated width of the individual lines. According to this estimate, in his band which was ruled at the rate of 500,000 lines to the inch, each line drawn by the machine was $\frac{1}{1800000}$ of an inch broad!

In reference to our previous article, we do not mean to imply that a band of 120,000 lines to the inch cannot be resolved. The theoretical resolving power of several objectives that have been made exceeds 120,000 lines to the inch, but we have never heard of their actual limit of resolution. The mere resolution of lines cannot be regarded as a test of the excellence of an objective, and if such a band is resolved by any objective now in use, we would be inclined to regard it as a strong indication that that objective is an inferior lens. This may seem rather a surprising and bold assertion; but the resolution-tests that have so long been relied upon as indicative of the excellence of objectives, have greatly retarded the progress of microscopy in this country and in England. They have led to the production of a class of costly objectives, in which general excellence has been sacrificed to resolving power. A few writers in England and America are responsible for this unfortunate condition of affairs. They have led a great many microscopists in both countries to place a false estimate upon resolving power, and to underestimate other qualities that are of equal importance. As a natural result, the makers of objectives have followed the public demand, and produced such lenses as would satisfy it. Only one of our prominent makers in America has pursued a conservative

course in this regard, and we are pleased to observe that the products of his workshop are now steadily growing in favor. We refer to Mr. William Wales. We do not mean to imply that the course followed by the manufacturers has been productive of no good. Undoubtedly it has resulted in much valuable experience, which will sometime be shown in a better class of objectives. But with this matter we have nothing to do at present.

What we desire to impress upon the minds of our readers is the fact that resolving power alone is not a test to be depended upon. The reason for this will be obvious to anyone who has studied the articles already published in this JOURNAL. When a difficult test is resolved, the extremely oblique rays that enter the objective are the only ones that contribute to the formation of the image of the lines. All the central portion of the objective might as well be stopped out. An annular zone around the periphery takes in all the light that is necessary to form the image. It is, therefore, a simple matter for the maker to correct the objective, especially for the rays entering that annular zone, the result of which would be, the objective would resolve lines beautifully, but its performance with the *Podura*-scale, for example, would be less satisfactory.

But now, lest we be severely criticised for our statement to the effect that, to put in another form, an objective can be made to resolve too much for its own good, we must clearly state the reason for such a conclusion. It is simply this: So long as makers are confined to the use of the glass now available, it will be impossible to correct the latter throughout, for central light and for light of excessive angular incidence.

As regards the value of test-plates of ruled lines, they serve very well to test the capability of an objective to resolve lines, but since there is no dioptric image from such a plate, the observer cannot judge whether the lines are seen in their proper plane or not. This point should not be overlooked. A diatom is a much better test, for then we have the dioptrical image of the frustule—the outline or the median line for example—in view with the lines, and if the lines are not in the same plane, or as nearly so as experience indicates they should be, then the objective fails to do its work well.

Not long ago several American objectives were compared with two by Zeiss, the test employed being *A. pellucida*. These comparisons were made by some members of the New York Microscopical Society. It was found that the American objectives gave rather better definition of the lines than the Zeiss, although this difference was scarcely noticeable. On the other hand, the Zeiss objectives showed the markings and the outline of the diatom together better than did the others—the two images were more nearly in the same plane.

CORRESPONDENCE.

TO THE EDITOR:—In the March number of your valuable MICROSCOPICAL JOURNAL, on page 54, under the head "A New Form of Vertical Illuminator," you call attention to "the ingenious device of Prof. W. A. Rogers," adding in parenthesis, "we believe it was invented by him." I have a $\frac{1}{8}$-inch objective, made by Mr. R. B. Tolles eleven years ago, with a prism fitted in the manner described. Mr. Tolles made one several years before he made mine for Prof. R. K. Browne. Please give the credit to the inventor. Very truly,

GEORGE B. HARRIMAN.

BOSTON, March 16th.

[In looking up the history of this device, we find that Mr. Tolles should have the credit of being the first to apply a prism in the manner described. This he did in the year 1866.—ED.]

MICROSCOPICAL SOCIETIES

At a meeting of the NEW YORK society, Mr. J. D. Hyatt exhibited some speci-

mens of a Boring Annelid, and described, by the aid of black-board drawings, the probable method of excavating in hard substances. He showed two mounted specimens, one with the jaws extended, and one in which the head was retracted far back into the body of the animal.

The track of an annelid, as Mr. Hyatt had found by cutting sections of shells, was always downward and then back to the surface in a line parallel with, and close to, the original channel, so that frequently a section across the borings shows either two channels with a very thin partition between them, or else without any wall of division.

Remarks were made by several members of the society, particularly concerning the method of boring. It was thought by some that the apparatus for boring described by Mr. Hyatt could not be hard enough to penetrate solid rock, but the weight of evidence seemed to be conclusive that no chemical action assisted in the process.

Mr. Hitchcock described the structure of sponges. His remarks were principally based upon the description of sponges in Saville Kent's *Manual of the Infusoria*. According to Mr. Kent's observations and also to others by Carter and by our countryman, Prof. H. James Clarke, the sponge consists of a mass of clear, homogeneous, jelly-like matter, the cytoblastema, traversed by ramifying canals which are enlarged in places. The cytoblastema is covered with an imperfectly differentiated investing membrane, and the spicules are imbedded in it. The canals are enlarged into chambers at different points, and these chambers, known as ampullaceous sacs, are lined with spherical or oval monads, each of which has a hyaline, bell-shaped collar at the anterior end, through the centre of which a long flagellum extends into the chamber. These collared monads also line the channels in some species of sponges. By the constant lashing of the flagella, currents of water are drawn through the pores, the small openings on the surface of the sponge, into the ampullaceous sacs, and from these they pass to larger channels which lead to the large openings or oscula at the surface. This constant circulation provides the sponge with air and food.

Within the cytoblastema are a great number of amœboid bodies which are difficult to distinguish from the mass in which they are imbedded. By the coalescence of these amœboids, which seem to be derived by a direct transformation of collared monads, one process of reproduction is accomplished. The other processes of reproduction were described.

Sponges appear to belong to the protozoa, although some authors believe they should be classed among the metazoa. The speaker was fully convinced of their protozoic nature.

An interesting address was recently delivered by Mr. Isaac C. Martindale, before the CAMDEN Microscopical Society on "Cell Structure in the Vegetable Kingdom," but the report of the address which we have is hardly suitable for publication here. The subject was illustrated by several objects under microscopes, among which were cyclosis in anacharis, desmids shown by Prof. Kain, a fern leaf by Mr. Bowden, *Volvox globator* by Mr. Clark, and *Glœocapsa* by Mr. Morrison.

A meeting of the STATE MICROSCOPICAL SOCIETY of ILLINOIS was held Friday evening, February 10th, 1882. Mr. E. B. Stuart read a paper entitled "Notes on the Iodo-sulphate of Quinia."

The speaker stated that some time ago it became desirable to ascertain if a certain sample of muriate of morphia contained traces of quinia. He found no published reference to the action of morphia on the iodo-sulphate-test of Herapath. This test had been a favorite with him for some time, partly on account of the ease with which it could be applied, and partly on account of the certainty of the reaction. He first tried the reaction on a solution containing one part of quinia and nine of morphia. The morphia in this mixture did not prevent the formation of the iodo-sulphate of quinia; nor did it have any effect when the morphia was in the proportion of 1,000 to 1 of quinia.

The mode of performing this test was to dissolve the salt in dilute alcohol, by the aid of sulphuric acid, and the solution warmed to about 100° F. Very dilute tincture of iodine is then added, drop by drop, with constant agitation. When a sufficient quantity of iodine has been added, the precipitate appears and quickly subsides.

In a mixture of the four principal cinchona alkaloids, the quinia is first separated, then the cinchonidia, which is followed in turn by the quinidia, and finally by the cinchonia. The latter reaction takes place very slowly, however, and only in tolerably concentrated solutions.

The separation of cinchonidia from

quinia by this method is far from complete, and unless present in large proportion, all the cinchonidia is likely to be precipitated along with the quinia. On recrystallizing from alcohol, however, the two salts separate and can be distinguished by the microscope, although not very readily. After crystallization, the shape of the crystals becomes definite, mostly appearing in thin rhombic prisms.

Mr. Wm. Hoskins spoke of the differences between the crystallization of the fat of butter and that of lard, tallow, and other fats. The speaker stated that upon melting, and then cooling the clarified fats slowly, the differences in the crystallization of the various fats were very marked, and that he was enabled in this way to distinguish positively, adulterations of suene, oleomargarine, etc., in butter.

On February 17th, the microscopists of DANVILLE, Ill., organized a microscopical society and named it the Griffith Microscopical Society of Danville. Rev. F. W. Taylor, President; J. C. Leavitt, M. D., Vice-President; Miss Sophia Andros, Secretary and Treasurer.

NOTICES OF BOOKS.

A Synopsis of the North American Lichens, Part I., Comprising the Parmeliacei, Cladoniei, and Cœnogoniei. By Edward Tuckerman, M. A., Author of Genera Lichenum. Boston: S. E. Cassino, 1881. (Pp. 262. $3.50).

For the student of lichens, this is almost the only book now to be obtained for a reasonable price. The two valuable English works "Lichen Flora of Great Britain" and the "Popular History of British Lichens," are out of print, and can only be found second-hand. It is to be hoped the second part of the work before us will be issued soon.

The lichens, according to the views of the author, are intermediate between the algæ and the fungi. In general, lichens are aerial thallophytes, vegetating under the influence of moisture, hence of slow and interrupted growth. The book opens with a concise description of the form, structure, the mode of growth and the fructification of lichens. This part, although condensed into only sixteen pages, is well worth careful reading.

The remainder of the book is devoted to the description of the genera and species, beginning with a key to the arrangement, similar to what is found in works on systematic botany.

We wish to urge upon our readers the examination and study of lichens. Although we cannot claim for ourselves any special familiarity with those plants, we have seen enough of their structure, and have read enough about them to be fully aware of the interest that must be attached to their study. Many readers have no special subject of study, and if some of them would take up the lichens, they would find far more pleasure in the intimate knowledge of these plants thus obtained, than can ever be found in general and superficial examination of the entire vegetal kingdom.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Unmounted Foraminifera from the north of Ireland for mounted objects. T. B. JENNINGS,
Signal Office, Springfield, Ills

Diatoms, recent, fossil and *in situ*; algæ, ferns, and much other first-class material to exchange for first-class material of any kind, prepared material, and particularly foreign diatoms, recent and fossil preferred. M. A. BOOTH, Longmeadow, Mass.

Having secured a supply of the microphotographic films used for transmitting news by pigeon-post during the siege of Paris, I will take pleasure in sending an unmounted specimen, suitable for microscopic use, to any person who will send me a stamped and directed envelope for that purpose. R. H. WARD, M. D.,
53 Fourth Street, Troy, N. Y.

Well-mounted slides of Pathological and Histological specimens, injected and otherwise, in exchange for Insects, Polariscopic or Pathological slides.
FRANK P. HUDNUT, Orange, N. J.

A slide of well-cleaned *Epithemia turgida* offered for any other well-mounted object or material.
H. S. WOODMAN,
P. O. Box 87, Brooklyn, E. D., New York.

A beautiful collection of wild seeds of Central Ohio to exchange. List furnished on application.
F. O. JACOBS, Newark, Ohio.

Well mounted Diatoms, etc., in exchange for first-class slides, or material. W. H. TIVY,
6th and Olive Streets, St. Louis, Mo.

Well mounted Diatoms on Alga, Polycistina, Zoophytes various, and other miscellaneous objects for other well mounted objects. Mounted Insects or parts of Insects preferred. W. FARNELL,
125 Walnut Street, Macon, Ga.

For a packet of frustules of *Biddulphia lævis*, send slide, or unmounted specimen to
K. M. CUNNINGHAM,
Box 874, Mobile, Ala.

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The Boring Sponge—Does it Excavate the Burrows in which it is Found? *

BY J. D. HYATT.

The little sponge *Cliona celata*, Grant, *Hymeniacidon celata*, of Bowerbank, is a common inhabitant of the waters around New York, and is also well-known on the coasts of the British Islands. Bowerbank, one of the best authorities on the subject of sponges, describes it as one of the simplest in anatomical structure of all the British species, and when we remember that the highest organisms of the order porifera are at most but a step removed from protozoa, it will not appear strange that many naturalists still doubt the ability of *Cliona* to excavate for itself the canals and spaces which it always occupies in rocks, shells and stones.

The living part of a sponge is a mere mass of jelly, or an aggregation of jelly-like bodies which, together, form a compound animal; but the individual members composing this animal may be separated from each other, and from the main body, without in the least impairing the other's vitality.

The only organ possessed by these little sponge-bodies is a vibratile cilium, or lash, the rapid motion of which serves the purpose of producing currents of water outward, through the osculæ, the inward flow being filtered through the numerous minute apertures or pores which open directly into the internal cavities. These currents seem to convey to the sponge such matters as are suitable for food; and this simple process is all that is required for the purposes of nutrition.

Sponge-colonies thus acting together, secrete for the whole a skeleton, or framework, which, in those most familiar to us, consists of the horny material which constitutes the sponge of commerce.

Imbedded in the body of the sponge we often find also silicious or calcareous spicules, of many fanciful shapes, resembling pins, needles, clubs, crosses, anchors, wheels, hooks, etc.

The framework of *Cliona* is almost entirely silicious, the spicules taking the form of pins, having a rounded head at or near one extremity, while the other terminates in a fine point (fig. 26). Some naturalists have supposed that these spicules were the tools used by this sponge in excavating rock and shells, but the evidence that they are used for this purpose hardly warrants the definition of *Cliona* given in the "Micrographic Dictionary," edition of 1875, which is as follows: "Cliona, Grant—A genus of marine sponges. By means of the spiculæ imbedded in their surface, they burrow into rocks, shells and stones." The evidence that this sponge burrows by means of its spicules, is not only wanting, but the supposition that it burrows at all, would seem

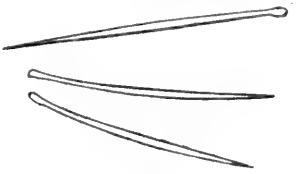

FIG. 26

* Read before the New York Microscopical Society.

to be still a matter of mere conjecture requiring confirmation by careful study and observation. My attention was called to this subject some time ago by the published reports of the discussions in the Quekett Club, of London, respecting the boring powers of this sponge, from which it would appear that very little was positively known, but that many good grounds existed for believing, that the burrows in which *Cliona* is found, may have been excavated by annelids, or some other of the numerous shell-borers and lithodomes, that are well-known to possess the necessary tools for mining such hard bodies.

The following are some of the principal reasons offered by Bowerbank, and more recently by other naturalists, for considering *Cliona* merely a "parasite" in the burrows which it occupies.

First: That the excavations could not be done mechanically with the spicules, was shown by the absence of muscular or contractile power in the sponge, or any indications of wear of the spicules, as would be the case if they were used as tools for abrading such hard bodies; and the supposition that the sponge secreted some acid fluid that enabled it to dissolve calcareous bodies and thus penetrate them, was pronounced improbable from the fact that upon chemical examination no acid could be detected.

Second: That in certain specimens examined, the sponge was found to occupy only the channels near the outer surface; and did not penetrate to their extreme interior limit, as would necessarily be the case if it had made the burrows itself.

Much stress was also placed upon a peculiar character of these burrows, which, it was thought, showed conclusively that they had been cut by the concentric strokes of a hard tool, like the jaws of an annelid. This is shown in fig. 27, which represents the appearance of the burrows in a thin section of shell, as seen under the microscope. The holes through such sections, instead of being bounded by continuous and regular curves, as it is claimed they would be if excavated by a solvent, present a series of irregular, concave depressions as if abraded or gnawed by some borer, much smaller than the canals excavated—the arc of a circle in these depressions generally

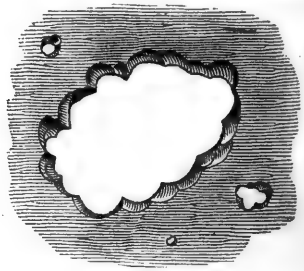

FIG. 27.

representing, for the excavator, a diameter of something less than the $\frac{1}{500}$ of an inch. It is also claimed that the burrowing larva of *Scolytus*, of corresponding size, was known to excavate in a similar manner. These evidences, coupled with the distinct assertion "that there is not on record any observation which proves the sponge to be an excavator," would seem to make a very strong case against *Cliona* as a borer.

A careful study of the literature of this subject, which is quite voluminous, extending over a period of at least forty years, convinced me that there was one weak point in the method which, as far as I could discover, had characterized all observations, and which consequently invalidated, to a great extent, the conclusions on both sides. This was, that those observations had been made upon dried specimens; or, as one author distinctly mentions, upon the live sponge occupying old shells and rocks. It occurred to me that a careful study of the live sponge occupying, and working upon, the shells of healthy, living and growing mollusks, might present some features or evidence, for one side or the other of this argument, that had hitherto been

overlooked, and, with a view of obtaining such evidence, but without the slightest prejudice as to which way it might lead, I procured some oysters that had recently been taken from the beds of the East River—a considerable number having shells tenanted by *Cliona*.

An exhaustive microscopical examination of these and similar specimens, which has occupied my leisure time for several months, presents the following features, which seem to me to establish, beyond a possibility of doubt, that the sponge is, in this case at least, the only factor to be held accountable for the burrows. The outer layer of these shells was punctured with numerous holes, often many hundred, varying from the $\frac{1}{20}$ to the $\frac{1}{100}$ of an inch in diameter, generally occupied by the osculæ of the sponge. Between the outer and inner layers, and extending laterally, the shell was almost entirely excavated, and the space occupied by the sponge and its numerous spicules; while extending inward from this sponge-mass were innumerable minute, branching and ramifying burrows, uniformly and completely filled with corresponding arms of sponge, many of which extend quite through the interior layer of shell, and are plainly to be seen under the microscope. The contact of these arms of the sponge with the external membrane of the oyster causes the latter to deposit at such points an additional amount of lime carbonate, and the interior surface of such shells presents the appearance of numerous little prominences caused thereby. The oyster in some cases seems to succeed in barring out the intruder, but in several of the shells here shown, the sponge, in almost every case, passes quite through. In view of the evidence presented by these shells, of the quantity of lime carbonate heaped about the puncture through the inner layer, it is apparent that the withdrawal of the animal excavating them would be followed, almost immediately, by the closing of such apertures.

The only possible theory that will account for these burrows, if they are not made by the sponge, is that they are the deserted excavations of annelids, or other marine worms; and from the conditions here shown this theory is utterly untenable, for we shall be required to believe that this shell was once inhabited by an innumerable multitude of such worms; otherwise the perforations through the inner shell would have been closed, and all of these must have retreated, at the same time, so completely that no trace of them could be found, and the sponge must then have extended its growth into the deserted channels with such rapidity as to fill every minute branch before the oyster could bar it out by the secretion of enough new shell to stop apertures the $\frac{1}{1000}$ of an inch in diameter.

But this is not all. The burrows occupied by *Cliona* branch in all directions and diminish in diameter as they extend inward, which would represent a method of boring quite inconsistent with the habits, or even the possibilities, of annelide, *Scolytus*, or any other known borer. Again, in these specimens, the sponge was found in small spots on the thin laminæ, around the sides and anterior edges of the shell which represent its most recent external growth, and in such cases the laminæ were perforated from side to side.

Respecting the concave depressions bounding excavated parts, I can only say that the large annelids, which, so far as I have been able to discover, are the only occupants of these shells except the sponge, are, from the character of their jaws, incapable of cutting such depressions, and, moreover, from their size, unable even to enter the burrows. These annelids have a curious habit of boring into the shell a certain distance and then turning or doubling upon their track; sometimes sweeping around a circle, they come out through a course so near that by which they entered as to cut the

two canals into one, or leave between them an extremely thin partition. A section of shell through which one of these annelids has mined a passage shows, under the microscope, none of the concave clippings attributed to it, but on the contrary presents a perfectly circular outline or unbroken curve, as shown in fig. 28, no marks of

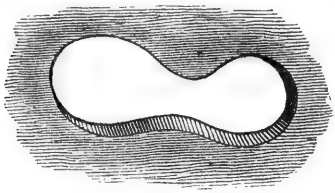

FIG. 28.

the jaws being seen with a magnifying power of 120 diameters—indeed, the path cut by this worm is so peculiar and characteristic that when once examined it could never, by any possibility, be mistaken for that made by any other borer.

The manner in which the sponge is able to work its way through rocks and shells I will not attempt to explain; but the form or contour of the aggregated sponge-mass, with its extended pseudopodia, corresponds very accurately with the outline of the spaces excavated as shown in figure 27. From the amœboid character of its living components, if we admit its power of excavating at all, then, every part of its exterior surface possesses that power, and the excavations occupied by it are exactly such as we should expect to find, the monad bodies of which it is composed fitting the concave depressions and its pseudopodia the smaller burrows.

Desmids and Diatoms.

BY PROF. H. L. SMITH, HON. F. R. M. S.

I have been interested in the papers upon "Reproduction of Closterium," by Mr. Holland, and on the "Motions of Diatoms," by my friend Mr. Vorce, published in the March number of your JOURNAL, and beg to offer a few remarks, not by way of criticism, but simply stating the conclusions that I have arrived at some time since, from the observations of many years and under varied conditions. The "swarm-spores" spoken of by Mr. Holland, are not a mode of reproduction of the desmids. The true reproduction is by conjugation, and the formation of a sporangium, as with the diatoms. It is quite true that moving spores, as observed by Mr. Holland, have been seen and described in the desmids by numerous observers, and Mr. Ralfs, in the "British Desmidieæ" gives a list of those who, at that time, had witnessed this "swarming," and, as something similar does undoutedly occur with other algæ, the conclusion was a very natural one that in the desmids these were true reproductive spores. Mr. Ralfs, admitting the fact of "swarm-spores," says, nevertheless, that in the state of science at that time he could not, if this were a mode of reproduction, explain the necessity for the complicated process of conjugation, and the formation of a sporangium. The latter he figures, in the case of *Closterium acerosum*, on the authority of Mr. Jenner, as a cell in which the minute fronds of this desmid have commenced their growth, and Oersted has figured the same for *Cosmarium*. No one, however, has ever observed in the desmidieæ, so far as I am aware, that the so-called "swarm-spores" are in any manner serviceable for the reproduction of the plant, or indeed, are at all like the zoospores *e. g.* of *Schizomeris* or *Œdogonium*. Wood, in the remarks upon the desmidieæ, in his "Contribution to the History of the Fresh Water Algæ of North America," does not even mention them, giving the true reproduction solely by conjugation. I have observed these spores imprisoned in the cells of *Closterium*, and moving freely, and have by me the drawings, made years ago; but what is stranger, I have repeatedly seen the same in-

side the large frustules of diatoms *e. g. Navicula major* and *Surirella splendida.*

It is not difficult to conceive how these may, in some minute and early form, have penetrated the frond of a *Closterium;* it is not so easy to see how they have entered an unbroken frustule of a diatom, but the fact is the same, and probably they had as much connection with reproduction in the one case as in the other. Mr. Holland's observations are interesting, and it is to be hoped that he will some day be able to trace the history of these, apparently desmid-spores, in all its stages.

In regard to Mr. Vorce's paper, it is marked by careful, well-matured statements, and the conclusions to which he has arrived, are, in my judgment, quite correct.

I have not the least doubt that the diatoms are enveloped by a membrane, out of which the stipes, tubes, etc., are formed; my reason for this opinion, indeed I may say the proof of the existence of this membrane, will be given in a paper upon the "Life History of the Diatoms," which will be published, I trust, before long. In that paper I have also hinted at an explanation of the movements, based on experiment and observation, but which, after all, may prove as unsatisfactory as those mentioned by Mr. Vorce.

These movements, so curious and so varied, are yet connected with the structure of the frustule, and we must not ignore this, in attempting to explain them, *e.g.* the nitzchiæ, which have a continuous raphe, *i. e.*, without median nodule, or break, move in the most lively manner, they are also long and slender; the stalked forms move when free, *Cocconema* for example, in a long curve, *Gomphonema* straight; the navicula group move in straight lines, but not in so lively a manner as the nitzschiæ. All these, except the last named, have a median nodule. The surirelleæ, which have the raphe along the four expansions, or *alæ* (two for each valve), move more sluggishly, rolling over frequently, and the amphiproreæ and other twisted forms, rock or twist as mentioned by Mr. Vorce, while the circular forms, like *Coscinodiscus*, which have the raphe probably all around the margin of the cingulum, or connecting zone, and edge of the valve, do not move at all, or if so, very sluggishly. The movement then is more or less regulated by the structure of the frustule, and in any explanation we must not forget this. The careful observations of facts meanwhile should not be neglected, and the publication of them, may give the clue or hint that will guide some other observer, possibly, to the true solution of a phenomenon as marvellous as it is at present inexplicable.

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Oblique Illumination, with a Special Consideration of the Capabilities of Immersion Condensers, and a Note on Symmetrical Illumination.

BY ERNST GUNDLACH.

The advantage of oblique illumination has long been acknowledged in microscopical research. For a long time the simple, easy, and common method of oblique illumination with the mirror seemed adequate for all needs. Afterward, as objectives were improved and their angle increased, it was found desirable to have the mirror swing out to the widest possible extent, to utilize the additional angle, thereby gaining in resolution.

But a little later, by the further improvement of objectives, more obliquity of illumination was demanded, and extremely thin stages and other devices were employed to get as near as possible to 180°, then the alleged limit of aperture. I say alleged limit, because most people then believed, and perhaps some now believe, that to be the limit of the theoretical angle of aperture. To such, if there be any, I would say

that a light-cone of 180° will give only half the light that a modern wide-angled objective can take in.

The alleged limit of 180° being exceeded by makers of objectives, the swinging mirror proved inadequate to send the light through the outer angle of the objective ; so condensing lenses, prisms, reflex illuminators, and very wide-angle dimmersion-condensers, both achromatic and non-achromatic have been constructed for this purpose. Of all this apparatus, the Abbe condenser has apparently been the most efficient, and has been generally adopted, either directly or as slightly modified by others (to no particular advantage), as the most suitable illuminator for the widest angled objectives. Hence, it is advisable to inquire whether this form of condenser is capable of doing all that is demanded of it now, or that will be demanded in the near future ; and to this inquiry I have given much special study.

The Abbe condenser, in any of its modifications, is a non-achromatic system of lenses, resembling an objective, so constructed as to combine as small a weight and size as possible with a certain very wide angle of aperture, and sufficient working-distance to work through the thickest object-slides. It has this advantage over most other forms of oblique illuminators, that, by means of a movable diaphragm, pencils of light can be made to pass through the objective successively from the center to the extremity of its angle without changing the axial position of the mirror.

As the full advantage of a very wide-angled objective cannot be had unless light can be made to pass through any part of its aperture at will, this form of condenser would be the best, if it were possible, practically, to increase its angle to correspond with that of the objective ; but it can be shown, and I will indicate the method, that it cannot be so increased, and that it cannot approach within 20° or more of 1.52 n. a., as is now, or soon will be, desirable.

If the point where the optical axis of the objective cuts the plane of the object be considered the vertex of an angle which has the extended optical axis of the objective for one side, then the other side of the angle extended downward will cut the underside of the slide on which the object is mounted, at a certain distance from the axis, and this distance is proportional to the thickness of the slide. Besides, if the said angle is equal to half the angle of aperture of the objective, then this distance is the radius of a circle which the available front of the condenser, or other apparatus, must cover, so that light may enter the objective at the most extreme angle of obliquity. If this distance, which we will call D, be three-sixteenths of an inch, then the available surface of the condenser must be a circle of at least three-eighths of an inch in diameter.

Now, assuming the thickness of the usual object-slide to be one-twelfth of an inch—though this is hardly enough—if the angle of aperture of the objective is given, we may find the distance D; for, with the thickness of the slide, one-twelfth of an inch, as the cosine, the distance D will be the sine of half the angle of aperture of the objective. If the angle of aperture of the objective be 120°, or 1.31 n. a. in crown-glass of 1.52 refractive index, then the distance D would be 0.144-inch, which, however, will not introduce any special difficulty in the construction of an Abbe condenser, as the connecting, or front surface, of the condenser need not be larger in diameter than 0.288, or a little over one-fourth of an inch. But when we come up to 140° crown-glass angle, or 1.42 n. a., the distance D increases at once to 0.228-inch, and the connecting surface of the condenser must be at least 0.456, or near half-an-inch in diameter. With so large a front sur-

face, or, as it is better expressed, front aperture, the condenser, to be fully up to 140° crown-glass, will have to be of an equivalent focus of at least one half-inch, which, with 140° in crown-glass, will make the back-aperture 1.42-inch, or near $1\frac{7}{16}$ of an inch*, and, in mounting it will be pretty close work to get this inside the substage tube. But let us go a step further and suppose an objective of a crown-glass angle of 160° or 1.49 n. a., which may be expected before long. This angle will increase the distance *D* to 0.47-inch, and the diameter of the front aperture of the Abbe condenser must be at least 0.94 or $1\frac{6}{16}$-inch. Now, as the increase of the angle of aperture of the condenser from 140° to 160° will consiederably lessen its working distance, it will have to be constructed of so much longer equivalent focal distanee as to keep the working distance of the slide thickness, of at least $1\frac{1}{3}$-inch focus, and even with this it will be hard to get the required working distance. But a condenser of $1\frac{1}{3}$-inch equivalent focus and 160° crown-glass angle will require a back aperture of 3.98-inches.

Attaching this mammoth condenser to a microscope having a stage, and consequently all the base parts that support it on the same scale, we would have an instrument of such proportions, as would give the appearance of a derrick, rather than that of a microscope.

These examples satisfy us that the Abbe condenser, useful as it is, by no means fully meets all the requirements of oblique illumination, and that practically this illumination can not very well be made of greater angle than it already has. Hence, we have either to find some other suitable means of obtaining still more oblique illumination, or to give up as useless, the increase of the angle of the objective for an increase in performance.

So, it is wise to consider the solution of this problem of illumination before the further improvement of the objective by the increase of angle. In this direction, I desire to submit for consideration the idea of an oblique light reflector represented in fig. 29. *S* represents the object-slide; *r* the proposed reflector. It is a section of a sphere. The upper, plane surface is to be brought in contact with the slide by means of a suitable fluid in the usual way. The under-surface is concave. The dotted lines show the direction of the light, which undergoes an inner total reflection at the surface *c*, *c*.

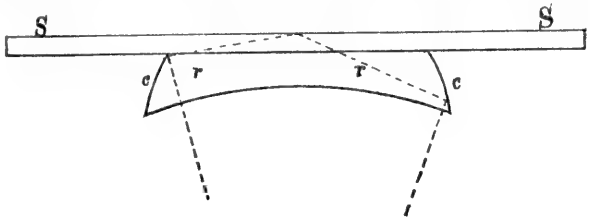

FIG. 29.

Perhaps this reflector will answer for the next limited period; and, when even this shall prove to be insufficient, I propose to mount the object on the plane surface of this reflector. In this way, the theoretical limit would be reached, and opticians can go on constructing objectives that will take and utilize the oblique light of this reflector.

* The radius of the actual (back) aperture of an objective is to the equivalent focal distance of the latter, as the sine of half the angle of aperture of the objective multiplied by the refractive index of the medium to which the angle of aperture relates, is to the radius of this angle.

Symmetrical Illumination. — Before concluding I desire to call attention to another idea, which, if carried out properly, may be of advantage. I thought that a good result would be obtained if the object should be obliquely illuminated symmetrically; *i. e.*, from diametrically opposite sides at the same time, with equal obliquity, intensity and quantity, rather than from one side only; for, the secondary spectrum, with the unavoidable slight chromatic overcorrection of the outer part of the objective, produces a more or less visible and disturbing spectrum, which will be neutralized in the proposed way. I have tried this; and, after some difficulty, I think I succeeded in obtaining a result in resolving which I could not get in the usual way.

From my limited experience in this matter, I can say, however, that this symmetrical illumination requires a very delicate fine-adjustment; the one I used gives a motion of only $\frac{1}{800}$ of an inch at a full turn of the screw; for, apparently, the two images, projected separately by the illumination from each side, do not move in the direction of the optical axis when the screw is turned; but they move each toward the side from which they are projected, and it requires great precision to get them to coincide perfectly. Further desirable experimenting in this, for which I do not deem myself competent, I feel obliged to leave to experienced and skilful microscopists; and I shall be grateful if informed of the results of any experiments tried by them.

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Photographing with the Microscope*.

For those persons who, like myself, are not skilled in the use of the pencil, a simple and inexpensive process of photographing microscopic objects is of great value. I have long felt the need of an apparatus for this purpose, and some time ago I prepared a dark room in which I could use the ordinary collodion process with sunlight. But unless one can set apart a room for such work, and can afford to spend a considerable amount of money for a good heliostat, and for the necessary apparatus and chemicals, there is but little pleasure in working with wet collodion plates. I have, at the present time, a long camera, specially arranged for photography with sunlight, which enables me to work without a dark room, but since I have not an entire house to myself, I cannot find room for it, and it is never used. Within the last few years, a more simple process of photography has been perfected, which is now very popular among amateurs for landscape views. This is the dry-plate process; and it is the application of this process to photomicrography that I desire to describe this evening. If my attempt is successful, I shall have the pleasure of preparing and finishing a negative before the close of the meeting.

Let me first describe a very simple form of apparatus which, while it meets all requirements, is quite inexpensive. I have here an ordinary camera-box with bellows (fig. 30).

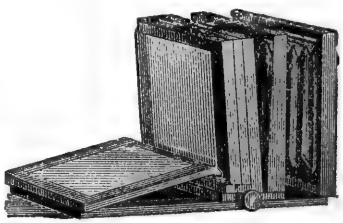

Fig. 30.

The apparatus consists of a board, 33 inches long, and as wide as the camera. At one end is placed the camera, which is fixed in position by cleats, so that it cannot be moved in either direction, although it can readily be lifted up from the board. In front of the camera the microscope, arranged horizontally, is placed with the end

* Read by the Editor before the New York Microscopical Society, May 5th, 1882.

of the body-tube just entering the small circular opening of the camera. A cone of opaque cloth is usually arranged about this opening to exclude extraneous light; but I have adopted a different plan, because it so happens that the bellows of my camera-box is long enough to give me all the range in magnification that I desire. The opening in the camera-front is about the same size as the end of my microscope-tube. Removing the draw-tube, I line the main tube with black cloth, to prevent reflection of light from the inside of the tube, which would make it impossible to secure a sharp definition, and then fit in the eye-piece by wrapping it with a strip of blotting paper. Over this I slip a card having a hole in the centre, and then, inserting the ocular, I place the microscope in position where the card, fitting against the front of the camera, completely excludes any diffused light.

In case I should, at any time, find it desirable to increase the magnifying power of my apparatus, I would cut a larger opening in the camera-front, and attach a hollow cone of the requisite length to connect the microscope and the camera. The cone might be of sheet-brass or tin, blackened inside, but one in every respect as good, and much lighter, can be made of paper in this way: After the proper dimensions of the cone are determined, take some writing paper, and paste upon one side of it a strip of black cloth—farmer's satin is very good. Then cover the back of the paper with paste, and roll up the cone, the cloth lining being inside. Three thicknesses of paper will make it quite stiff. I use the same plan in lining my microscope tube, and you can see what a serviceable tube can be made in this way. Beyond the microscope are two ordinary condensers—the one nearest the source of light, which is a student's lamp, is a bull's-eye lens; the other a small, double-convex lens. Two condensers are used, because a brighter illumination of the object can thus be obtained.

At the back of the camera is a plate of ground glass, upon which the image from the microscope is received. The image is focussed carefully upon this plate, by means of a simple lens; or, by what is still better,

FIG. 31.

a photographer's focussing-glass (fig. 31). It is essential to the success of the operation that the image be carefully focussed; and when very delicate structures are to be photographed it may be desirable to use a plate of clear glass instead of the ground glass. When the clear glass is used the lens of the focussing-glass must be adjusted so as to focus upon the inner surface of the glass, and then the image is made distinct by turning the fine-adjustment of the microscope. A so-called "bank-note detector" is also excellent for this purpose. Before attempting to use the apparatus, it is necessary to adjust the microscope so that the optical axis shall be perpendicular to the plane of the ground glass. This adjustment is best made at night, in the following manner: A perfectly flat object, such as a section of wood, is placed on the stage of the microscope, and the image on the ground glass is carefully examined. The microscope is then moved about, if necessary, until the image is as perfect as possible on every part of the ground glass. When this is done the stand should be fixed in its place by cleats, so that it can be replaced in position at any moment. Then the light and the condensers should be adjusted for the best effect, and the proper positions for the former marked on the baseboard. To adjust the light, remove the ground glass, the ocular, and the objective; and, placing the eye so as

to look through the tube of the microscope, place the light in the axis. Then arrange the condensers, put on the object and the lenses, and focus on the ground glass. The focussing may be done by a focussing-rod running from the back of the camera and acting upon the fine-adjustment of the microscope. This is a necessary arrangement when the observer cannot reach the focussing-screw while looking at the ground glass. But I have not found it necessary with this apparatus, for I can reach the fine-adjustment quite readily.

When the image is distinct upon the ground glass, the fine-adjustment should be moved so as to withdraw the objective more or less from the object, to focus the chemical rays. Just how much the tube must be withdrawn must be determined for each objective.

When everything is properly arranged, the sensitized plate, which is in the plate-holder, all ready, is placed in position. The plate-holder may be constructed to hold either one or two plates. For microscopical work one holding a single plate is sufficient, and such a holder is the cheaper.

The sensitized plates used in the dry-plate process can be purchased in packages of a dozen, and they are not very costly. The camera I am using is made to take plates five inches wide by eight in length, and such plates cost $1.80 per dozen. This size, however, is not suitable for microscopical work. I have made a frame for my plate-holder which enables me to use plates five inches by four, which only cost $0.95 per dozen, and these are large enough for ordinary work. A square plate would, of course, be better, but square plates are not used by photographers, and therefore cannot be found in the market. I could easily arrange to use a plate five inches square in my holder. Mr. Adams, the manager of the Scovill Manufacturing Company, has taken some interest in the subject of microscopical photography; and I have been trying to induce him to manufacture a camera especially adapted to microscopical photography. If such a camera is made, as I have no doubt it will be soon, it should have a longer bellows than the one before you, and square plates should be used. I think plates five inches square would be the most satisfactory size for general use.

The plates are sensitized by coating them with what is termed a gelatin emulsion. Without giving the details for the preparation of the emulsion, I will say that it consists of a solution of gelatin holding in suspension minute particles of silver bromide. The particles of bromide are so minute that they can hardly be seen by the aid of a microscope. When a thin film of the emulsion is dried upon the glass plate, the plate is extremely sensitive to light. Wherever a ray of light strikes the plate, a molecular change is produced in the particles of silver bromide. When the plate is exposed in the camera, the image of the object to be photographed is impressed upon the bromide by the action of the light, and the amount of change is proportional to the intensity of the light. Hence, where there is an image of a white object, or, what in microscopical work with transmitted light amounts to the same thing, where the light passes to the plate without passing through the object, the change is greatest, and with every different shade there is a proportional difference in the action on the plate. Opaque structures, or those which transmit only red or yellow rays, prevent any change in the sensitive surface.

But after the plate has thus been acted upon by the light, whatever change has taken place is quite invisible. The latent image will remain invisible for an indefinite time, if the plate is preserved in darkness. To make it visible it must be developed; and although this operation should be done in the dark room, lighted by a lantern with ruby glass,

such as I have here, I shall endeavor to perform the operation this evening so that you may all watch the development of the image. The developing solution consists essentially of some reducing agent—sulphate of iron, for example, or pyrogallic acid. These, when properly applied to the surface of the exposed plate, cause a reduction of the silver over those parts which have been acted upon by the light, and all those parts become dark and more or less opaque. It is in those parts of the negative, which correspond to the light parts of the object, that the details of the picture are to be looked for as the development proceeds. After the picture is fully developed it is washed, and fixed in sodic hyposulphite. This removes all the unchanged silver bromide, and clears the plate. The plate is then set aside to dry, and is afterwards varnished, when it is ready to be printed from.

For photographing from the microscope by lamplight, it need hardly be said that the plates should be very sensitive to light. It might be inferred, therefore, that the most sensitive plates are the best for this purpose. But it is doubtful if this is so. I am not able to speak from experience in this matter, never having used the most rapid plates, but I should expect to find more detail in a negative from one of the less rapid plates. I have made use of only one kind of plate—the "Keystone Rapid" plate "B," and the results have been quite satisfactory. The time of exposure varies with the structure to be photographed. The object I have chosen for this evening is one which I have not previously tried, an insect mounted in Canada balsam, but the image leads me to think a comparatively short exposure will suffice. To photograph an object which is yellowish or red, although the form of the object would be quickly impressed upon the plate, to obtain the details—the delicate shading of the different parts, which is necessary to give character to the photograph—would require a much longer time. The reason for this is that the red and yellow rays act very slowly upon the silver-salt. Therefore no definite instructions can be given. However, yellow rays, as Prof. Kain has observed, act upon the dry-plates with comparatively greater activity than they do upon collodion wet-plates. In Prof. Kain's article upon this subject, published last month, the relative exposures for several different objectives is given.

The highest power I have yet used with this apparatus is a so-called ½-inch and the lowest ocular, which gave a magnification of about 300 diameters. The combination that will be used this evening is a Gundlach 1-inch and the same ocular. The magnification thus obtained is 85 diameters. I shall expose the plate about one and a half minutes.

I see no reason why a power as high as a ¼-inch objective cannot be employed with satisfactory results with the same source of light. However, the electric light will doubtless be available for this purpose before long, and with that there will be no difficulty in using very high powers, as Dr. Van Heurck has already done. But if lamplight proves inadequate for the higher powers, sunlight can be employed with the same apparatus. Moreover, with the dry-plates sunlight can be used without a heliostat, for the exposure required is so very brief that the sun will not leave the object before the exposure is made, if one works expeditiously. While writing this I received a letter from Mr. John Carbutt, of Philadelphia, who has devised a lantern, the patent for which was issued last month, which he thinks will be of great assistance in microscopical photography I do not know what special advantages are claimed for this lantern, but probably it gives a very intense light.

Those who wish to undertake the work of photographing from the microscope will, I am sure, find it very

enjoyable, and it is really very easy to make good negatives by lamplight.

As for the printing on paper, I would not advise amateurs to undertake to tone and fix his paper prints. It is a more or less troublesome operation, and requires some experience to do it well. Sensitized paper can be bought in sheets, and it is well enough to get a printing frame and to do the printing if one has time, for the microscopist can print from his own negatives better perhaps than an experienced photographer who is ignorant of the special features to be brought out. But the subsequent processes of toning and fixing had better be entrusted to practical photographers who are prepared to do much better.

There is a small, but very useful and practical book which I can recommend to anyone who desires to learn the details of making dry-plate negatives—"The Photographic Amateur," by Mr. J. Trail Taylor, who has kindly volunteered his valuable assistance in making a negative this evening. This book was written especially for amateurs in field photography, but it contains all the information the microscopist will require, and it is sold for half a dollar.

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Hints to Amateur Microscopists.

BY REV. W. S. FALKINBURG.

I presume that one, at least, of the almost imperatively necessary qualifications of a microscopist is ingenuity. When one is a thousand miles from the manufactory of accessories, or when, if he were within one square, on account of the lack of the "root of all evil," he is unable to purchase what he needs, a friend helps him to make it for himself, or helps a near neighbor to do it for him, I think it certainly is the act of "a friend indeed." I have the misfortune to belong to the class whose "ship has not come over," and as the family of these is large, let me tell how I improvised an excellent bull's-eye condenser, hoping that I may help some brother microscopist.

First I cut a disc of sheet-tin, 2 inches in diameter. Then, using a piece of French plate-glass (as thin as possible), I cut it, as near the size of the tin as I could, with a steel-disc glass cutter; then, with a pair of scissors held unter water, I cut the glass to the exact size and shape of the tin, then ground the glass upon a grind stone, until it was round and smooth. Then, taking an old-fashioned bull's-eye watch-crystal, such as watchmakers have, I ground the side that would be next to the face of the watch, until it laid perfectly flat and snug upon the plate-glass. Then, after carefully cleaning the glasses, filled the crystal with warmed glycerin, and covered it with the plate-glass, just as we drop the cover upon a slide, so as to enclose no bubbles.

Then wipe off the overflowing glycerin and cement the edge of the crystal with gold-size.

I then made a cell of sheet-brass, but a blacking box of the right size will answer. Solder a tin or brass tube to the side of it. Fit a ¼-inch wire into the tube. Let the wire pass through a cork placed upon an upright rod, and fasten this into a solid foot, and it is complete.

My condenser is a plano-convex, 1½ inches diameter and of 3 inches focus.

I have painted the brass and other work, and have used it daily to perfect satisfaction.

GREENWOOD, IND.

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Double Staining with Carmine and Anilin Green.

The preparations used by the writer for the above process are those recommended by Geo. E. Davis, F. R. M. S., in his work, "Practical Microscopy," just issued.

The formula for the carmine stain is: carmine, 15 gr.; ammonia, 15 gr.; distilled water, 2 oz.; dissolve carmine in ammonia over the flame of a

spirit lamp, add the distilled water and filter.

For the green stain : anilin green, 5 gr.; absolute alcohol, 1 oz.

Very beautiful results are obtained from the following method of using these preparations together. The section is immersed from five to ten minutes in the green, and then passed at once into the carmine, in which it remains from one to three minutes, the process being carefully watched in order that the carmine may not stain too deeply. It is then thoroughly washed in absolute alcohol, passed through oil of cloves, and then mounted in solution of balsam in benzole. The use of the benzole-balsam is important, as it has a decided action in fixing the stain, due to the presence of benzole. Two or three drops of each liquid suffice, and the whole operation is performed upon a glass slide, or in a watch-glass.

The woody parts of the section take a rich carmine, shading into orange, while the pith and light cellular tissue are stained a bright orange-yellow. In a section (transverse) of the leaf-stem of the sago-palm, the outer cells, which are smaller and more compact than the more central ones, were dyed a rich orange-yellow, and their nuclei a bright carmine. The curious large ducts in the central portion of the stem, which, as a system, form in a transverse section a figure like the Greek capital omega, take a pleasing variety of shades, the cells around the edges being a bright orange, the central cells shading down to deep carmine. These sections of the mid-rib of the sago-palm, by the way, are beautiful objects stained or unstained, and one of the best examples of curious cell arrangements to be found anywhere.

The action of the dyes made from the above formula is quick and certain, and the effects very satisfactory.

T. W. Taylor.

A Food Habit of Difflugia Pyriformis.

BY DR. A. C. STOKES.

It is well known that the orange-colored, Actinophrys-like rhizopod *Vampyrella lateritia*, feeds upon the cell-contents of spirogyræ, but has it been observed that the shell-bearing form *Difflugia pyriformis* has a similar habit? Such, indeed, is the case, and *Difflugia*, if more deliberate than *Vampyrella*, is quite as voracious. I have seen one individual despoil four spirogyra-cells of their contents in about three hours and have its activity thereby increased, although the creature must have been gorged.

Having come to rest upon a filament of the alga, the rhizopod perforates a cell-wall, whether by pressure alone or in some other way does not appear; probably, however, by digestion, since, when the spirogyra-cell is seized by its free end, it is drawn into the mouth of the shell, and presumably comes in contact with the endosarc, and when taken in any other position the whole cell is forced into a curve, so that the shell rests upon the convexity, the upper wall being drawn within the mouth and marked by diverging wrinkles. Through the opening, pseudopodia enter and, uniting, seem, from the first, to form a sarcode lining between the cellulose wall and the chlorophyll band. As the sheath of animal protoplasm slowly advances, the chlorophyll band falls and, losing its distinct, crenated outline, becomes partially disintegrated and is borne toward the shell by a reverse central current. When the cell is half-emptied, the sarcode envelope is more distinctly developed, the free extremity being especially thick. Finally, the whole slowly disappears into the shell, and pseudopodia of the ordinary form then explore the empty cell and pick up any fragments that may remain.

Trenton, N. J.

Collecting at the Thousand Islands.

The Thousand Islands afford a good field for fresh-water material. Nearly every form found in the Great Lakes and their tributaries can be found there in greater or less abundance. Winrows of *Nitella* are found in Crystal Bay at Thousand Islands Park. Swarms of hydras may be gathered under the leaves of pond-lilies at the foot of "Seven Isles," or in the "Lake of the Island." Water-weeds of various kinds have their rich slimy coating of diatoms ; surfaces of rocks in places have a thick coating of fine algæ and infusoria. River Gananozne gives the diatoms of Canada with nostocs, myxomycetes and confervas in abundance.

Bays where streams empty are rich in black mud and various algæ. Barren rocks have their lichens, with parasitic lichens. Diatoms though mostly of smaller forms, nearly exhaust the first two fascicles of Van Heurck's *Synopsis*. Nearly everything microscopical may be found here that grows in our northern climate, being the great reservoir of many waters. Take along your microscopes. J. M. A.

EDITORIAL.

Subscriptions.—Remittances for subscription should be made by post-office, or express, money-order, by drafts payable in New York, or in registered letters. Money sent in any other way will be at the sender's risk. A receipt will be immediately given for money received by open mail.

Water Colored by Algæ.—In England the formation of a green scum upon the surface of ponds is called the "breaking of the meres." It is caused by the rapid growth of algæ of different kinds.

Long ago one of the plants which caused this appearance at Ellesmere, Eng., was described as *Echinella articulata*, which is given in Rabenhorst's "Flora Algarum," III, 386, as *Chætophora punctiformis*. This is a plant with tapering filaments growing out from a common centre, forming minute, globular, transparent, green masses, the filaments growing to about 0.7 mm. in length, with a spherical cell at the base of each.

Mr. M. C. Cooke, in *Grevillea*, has drawn attention to some other algæ, which have caused a similar appearance. In a lake near Aberdeen, spherical bodies of $\frac{1}{24}$ to $\frac{1}{12}$ of an inch in diameter were observed in great abundance. This was named *Rivularia echinulata*, and along with it was found an alga named *Trichormus flos-aquæ*, Bory. We are unable to identify the *Rivularia* under the proper name according to the present classification, but doubtless it is a species of *Chætophora*.

Another alga, which was found in great abundance in Ballydrain Lake, was described as *Anabæna spiralis*, but afterward transferred by Rabenhorst to *Spirulina* and named *Sp. Thompsoni*.

Among the other algæ mentioned in this connection are *Anabæna flos-aquæ*, Bory, *Sphærozyga flos-aquæ*, *Oscillatoria ærugescens*, and *Osc. rubescens* which forms a reddish scum. The *Anabæna flos-aquæ*, Bory, may be Rabenhorst's *A. circinalis*.

Last year, the water in the ponds of Central Park, in this city, was occasionally colored very deeply by a species of *Anabæna* to which we have not ventured to give a specific name as yet. This we found in abundance in the large lake, and also in a pond not far from the Museum of Natural History, in August. Mingled with it was *Anabæna bullosa*.

At other times we have seen the water near the cave, in the Park, colored with *Oscillaria*.

Other species produce the same phenomena, and whenever any of our readers observe the coloration, we would be glad to have them inform us of the cause.

About New York, a green and a very bright-red scum is formed by *Euglena viridis*, which is at one time green, and later becomes red. This,

however, can hardly be claimed as an alga.

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NUMERICAL APERTURE.—We have reason to believe that a plain statement of what numerical aperture is, will be acceptable to some of our readers.

In the first place, a few words about angular aperture. Suppose we have a dry objective with an angular aperture of 157°. Testing the resolving power of this lens, we find that it will resolve about 95,000 lines to the inch, and no more.

Take now a water-immersion objective that will just resolve the same lines, and a homogeneous-immersion that will do the same, and measure the angular aperture of these in the respective immersion fluids. In this way we find the angular apertures of the immersion lenses corresponding to the angular aperture of the dry lens; in other words, we find the angular apertures in air, water and oil, which correspond to a certain resolving power. These three corresponding apertures are about 157° in air, 95° in water and 80° in oil.

According to the old notion of angular aperture, the larger the angle the greater the resolving power. But, in this case, the actual effect is the very opposite, for, as we introduce immersion media the angle grows less, but the resolving power remains the same. Evidently, therefore, the old notion was wrong in some way. Increase of aperture in a given medium, as air, water, glycerin or oil, does give greater resolving power, and thus far the notion is well founded. But since, in passing from air to water, from water to glycerin, and from glycerin to oil, the angle of aperture grows less, while the resolving power remains the same, it is clear that resolving power does not depend alone upon the angle of aperture. Some other element must be considered, and it naturally appears that this is dependant upon the immersion-fluid,—there is some relation between the angular aperture, the immersion-fluid, and the resolving power. It has been found that the index of refraction * of the immersion-fluid is the element to be considered.

Before explaining numerical aperture, let us inquire what practical value it has. It was stated above that 157° air-angle was equivalent to 95° water-angle. A manufacturer of objectives makes a water-immersion lens and perhaps marks it as 157° dry-angle. Such a mark is proper enough, since the lens resolves the same as a dry objective of that angle. Nevertheless, it has no dry angle, and therefore it should be marked 95° water-angle. Well, suppose it is marked 95° what does this mark signify? Suppose we wish to compare that objective with others, some dry, some glycerin-immersions, some oil-immersions, how can we tell how these lenses should compare in resolving power? We would be obliged to take the apertures marked by the makers for the different media, and, by troublesome calculations, reduce them all to corresponding apertures in any one of the four media. Not until we do that can we tell whether a dry objective of 160°, a water-immersion of 110°, a glycerin-immersion of 90°, or a homogeneous-immersion of 70°, in their respective media, should resolve the finest lines, if all are equally well made.

Numerical aperture, however, tells at once the resolving power of a lens, no matter whether a dry-lens or an immersion in any fluid whatever. Numerical aperture, therefore, considers not only the angular aperture, but the effect of the refractive index of the immersion-fluid upon the angular aperture. It expresses the numerical relation between these two. It is determined by measuring the angular aperture and the refractive

* The index of refraction of any medium is the numerical relation of the sines of the angles of incidence and refraction.

index, and multiplying the refractive index (i) by the sine of half the angular aperture ($sin.\ ½a$); $i \times sin.\ ½a = n.\ a.$

All objectives having the same numerical aperture, have also the same resolving power, whether they work dry, in water, oil, or in any other fluid. Thus a numerical aperture of 0.98 corresponds to an air-angle of 147° 29′, a water-angle of 92° 24′, an oil-angle of 78° 20′, and to a resolving power of 92,544 lines to the inch. A numerical aperture of 1.00 corresponds to the theoretical air limit, 180°. So far as we know, the highest numerical aperture yet obtained is 1.43 for a homogeneous-immersion 1-12-inch by Mr. T. Powell. This corresponds to an oil-angle of 140°, and, according to theory, should resolve 137,000 lines to the inch. The highest angle for a water-immersion is 1.32 n. a., or 155° for a ⅛-inch by Powell & Lealand, which should resolve 125,000 lines to the inch.

Next month we purpose giving a table of numerical apertures with their corresponding angular apertures and resolving power in different media.

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Aperture and Resolution.—Mr. Gundlach's article on page 85 is worthy of consideration by those who believe that the celebrated ⅛-inch objective, recently made by Bausch & Lomb, is capable of resolving a band of 152,000 lines to the inch. By referring to a table of theoretical resolving power for different numerical apertures, it will be seen that in order to resolve such a band, the numerical aperture must be above 1.52, which is equivalent to 180° in oil, and this would require an immersion-condenser, according to Mr. Gundlach's calculations, with a "back aperture" of over four inches in diameter.

While writing on this subject, it may be well to call attention to the fact that the appearance of lines in the image is no evidence that the image is produced by lines. This fact seems to have been quite overlooked by some writers. The dots of *P. angulatum* may be made to appear like lines, and many other cases of similar nature might be cited. Again, the number of lines in an image is, alone, no evidence of the number on a lined object under examination. Prof. Abbe and Mr. Crisp, of London, have given satisfactory ocular proof of this fact, and also Mr. Warnock, of this city, who has a plate with a known number of lines in a given space, with which he occasionally entertains his friends by so adjusting the light that the number of lines in the image is doubled.

In a previous article we have demanded proof of the number of lines in Mr. Fasoldt's bands, by photography. But photography will represent what we see, and in this connection is only of value in so far as it enables us to readily count the lines, and thus compare the number in the image with the number claimed by the maker of the plate. It is of no other use whatever. If the image shows the same number that the maker claims, the presumption is that the claim is correct. If it shows a greater or less number, it is proof that the claim is not well-founded. But the fact must be always borne in mind that the presence of lines in a photograph does not prove that the object is a lined object. We do not see the fine lines in a band, but we see the spectral images which that band produces.

Although we have freely expressed our opinion concerning the claims made for the ⅛-inch objective of Bausch & Lomb, it should be fully understood that we have not intended to express any opinion against the excellence of the objective. On the contrary, during the short time when one of the objectives was in our possession we were much pleased with its resolving qualities, as manifested on *A. pellucida.*

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IMPROVEMENTS IN MICROSCOPES.—Mr. W. H. Bulloch has been constantly improving his stands and adding some ingenious devices during the past year. He has made several "Biological" stands with rack and pinion to the sub-stage. He has made a supplementary stage for use in arranging diatoms, which is doubtless very useful for that purpose. It fits into the substage-ring and a stem projects up through the hole in the main stage. Upon the stem there is an arrangement like a double nose-piece, which carries two glass slips. One of the slips is intended to carry the material from which the diatoms are to be selected; the other the prepared slide upon which they are to be mounted. The two slips can be moved about independently upon their supports. The hair or bristle, is mounted on the mechanical stage. The slide carrying the material is first focussed, the diatom picked up, the supplementary stage is turned until the clean slide is in focus, when the diatom is placed in position.

For a long time Mr. Bulloch has discarded the indefinite system of marking oculars by letters, and has designated his by their focal length, or magnifying power.

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THE MICROSCOPE TRADE.—That there are certain principles which must never be lost sight of in the successful conduct of business, no argument is needed to prove. When a number of persons are rivals in business, it is not always true that the one who does the largest trade is the most successful; but those who, pursuing a conservative and even course, making every sale more than pay the expenses incurred in effecting it, are, in the long run, the ones who find business profitable. Not only is such a course best for the merchant, but it is sure to prove most satisfactory to the customers.

It is a lamentable fact that all who are engaged in the microscope trade in this country, have not appreciated the application of these facts, and of a few others which are quite as self-evident.

The microscope trade here should be more profitable than it is to-day. It has been injured by a neglect of proper business principles, not to say by unfair dealing. We regret the fact, because good business leads to rapid improvement in manufactured articles. Legitimate competition benefits both merchant and purchaser, but to undersell a competitor for the sake of securing custom, is not fair business, and the effect upon the customer is not good for the seller.

It is customary for dealers in microscopes to sell to colleges at a discount from list-prices. This is proper enough, but when professors in colleges assume the role of dealers, and sell to students and others on the same terms, the effect is most unfortunate. Manufacturers are responsible for the custom, and no doubt it originated in over-production. The market has been overstocked with microscopes. We have been informed of some dealers who make it a practice to sell microscopes to individuals, at ten and twenty per cent. off the catalogue prices. Perhaps this is none of our business. We think it is, however. It is to our interest to expose abuses in the microscope trade, just as much as it is to prevent, as far as possible, the sale of inferior and useless microscopes. "A word to the wise is sufficient" —sometimes.

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LIFE IN A JAR OF WATER.—Looking over some jars of water a few days ago, that had been standing for months in a window, one of them, a quart specie-jar having a single growing spray of *Nitella*, with some vegetable debris at the bottom, was found to contain hundreds of hydras, attached to the sides and to the plant. These were the progeny of about half a dozen specimens that were placed in the jar a couple of months previously. By occasionally feeding the animals

with entomostraca, they will flourish in an aquarium for an indefinite length of time.

The hydras, as first observed, all belonged to the common green species, *Hydra viridis*. Later, however, we were able to find a flesh-colored hydra among them, belonging to a different species. These flesh-colored forms were rather larger than the green ones, and the tentacles were much longer, and more slender and graceful. They belong to a different species, *Hydra vulgaris*. In another jar, in which an abundance of *Nitella* had been vigorously growing all winter, a small, feathery, olive-green ball was observed, the nature of which was quite unknown until it was examined under a microscope. It floated free in the water, and was readily drawn up in a dipping tube. A glance through the microscope revealed its nature. It was a young *Tolypothrix*, which, upon further study, proved to be *T. muscicola*, a common form. The characteristic feature of this genus of algæ is the peculiar manner of branching. The filaments are straight through the greater part of their course, but where they branch, the lateral filament runs along for a short distance almost parallel with the main filament, and then diverges from it. The color is dark-green, or olive-green as it is usually called. How it ever came to grow in the jar is a mystery; for it is long since we found that plant in any of our collections. The spore must have remained latent in the jar for months before it began to grow.

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Newspaper Science.—What is the irresistible force which seems to pervade the editorial sanctums of nine-tenths of our newspapers, and impels them to select the absurd nonsense of ignorant and sensational writers for publication as scientific knowledge, when they might, at the same cost and with no more trouble, fulfil their true mission as public educators? It seems as though there was some baneful influence at work which, with a strong and unfortunate fatality, leads our journalists to select the false in preference to the true. Is it possible that such "news" is more attractive to the public? Or do Editors think it is? Our own experience leads us to believe that in New York City, the editors of our best newspapers will publish absolutely erroneous articles upon scientific subjects, rather than submit such articles to the perusal of persons competent and willing to criticise them. So long as the sale of the paper is not injured by them, the public must have such articles foisted upon it as "scientific news."

We are led to say all this because we happened to notice an article from the *Mechanical News*, headed, "Power of the Microscope," the following quotations from which are too absurd for criticism:

"There is a difficulty in determining the exact degree of magnifying power." "It has been found that in microscopic observations the use of the electric light makes it possible to illumine at least 500 times stronger than with gas." "By what is known as Chevalier's method, the light is separated by its difference in refrangibility so that the heat rays are almost excluded." "Bold as the attempt may seem, microscopists have undertaken * * * to estimate the size of the ultimate elemental particles or atoms of which all matter is composed." "The startling belief is expressed that the common house-fly is able to see and distinctly recognize these inconceivably minute particles, its eye having been found equipped with a peculiar circular muscle, unknown to early entomologists, which enables it to so change its focus and apply its lenses as to attain this incredible visual power."

What a conglomeration of error and deliberate falsehood is revealed in these quotations! We only know of one man who would be likely to write such an article, even for pay, and we strongly suspect this is only another of his indiscretions. But is not the *Mechanical News* ashamed of itself for printing such nonsense, and *Good Health* also for copying it?

NOTES.

— In the *Popular Science Monthly*, of April, there is an interesting sketch of M. Louis Pasteur, with a portrait of that distinguished investigator. Pasteur is a man whose name will always be closely associated with investigations of ferments, and the organisms connected with disease. He is an excellent chemist as well as a close observer with the microscope. Few men, indeed, have worked so earnestly in science as Pasteur, and few have lived to see the results of their labor so widely appreciated.

—Messrs. J. W. Queen & Co. have a series of twenty-four sections of starch-bearing vegetables and starch-granules which they recommend as polariscope objects. We should think they would be very attractive objects, for a section of a potato mounted for the polariscope is very gorgeous. We do not know the price of the set, and we have not seen the slides, but they are probably well mounted.

—Mr. W. H. Bulloch claims to have been the first to introduce an iris diaphragm fitted with the society-screw for use above an objective. In his catalogue of 1878, page 8, he refers to this sentence: "The Iris Diaphragm has the society-screw so that any objective can be used for condenser, or it can be used above the objective as an adapter, to reduce the angle of light in the instrument." He caims priority of invention on the ground of having been the first to publish a description of it.

—Mr. E. S. Nott writes that he found last month *Amphipleura pellucida* in a small brook at Hamburg, in Erie County, New York State. He states that it is smaller than those of Möller in the ratio of 12 to 16, and the lines are correspondingly finer.

— Rev. J. J. Halley, of Melbourne, Australia, recently adressed the Royal Microscopical Society of London, describing a process of preparing wax cells that had proved to be durable.

A mixture of wax and spermaceti (about ⅙ part of the latter) is placed upon the middle of the slide, and the surface made perfectly level. The slide is then placed on the turn-table and the cell turned up out of the solid wax.

—Dr. J. Muller, of the University of Geneva, has made some observations upon a lichen, *Cœnogonium pannosum*, which bear strongly against Schwendener's hypothesis. He finds in this species that the filament which contains the gonidia, and which, if the lichen is an alga with a parasitic fungus, would be the algal filament, suddenly narrows from a diameter of 8μ to only 2μ. The narrowed filament corresponds with the so-called fungus-hypha of other lichens, but a very careful examination shows that it contains micro-gonidia, and is not a fungus-filament. A translation of this article is published in *Grevillea*, of March,

CORRESPONDENCE.

On Amphipleura Pellucida.

To the Editor:—American microscopists can, with a few exceptions, be divided into two classes, namely, those who test objectives and demand wider angle for them, and those who are laboring for the improvement of microscope-stands. In the second mentioned class are those who are trying to pursuade makers of the instrument to adopt uniform names and sizes for accessories to the microscope. Belonging to both classes are those who desire that the metric system of measurement shall be used in microscopical work. I belong to the first named class, ranking in ability next to the lowest man. For enlarging our knowledge of microscopical natural history, we Americans rely mainly on observations abroad.

An American, experienced in using the microscope, who succeeded with an objective, theoretically competent, in showing the lines on *Amphipleura pellucida* —the first "resolution" of those lines ever made, perhaps,—subsequently found that at the time of such first "resolution," he had been for eighteen months the possesser of another objective, by a different maker, less capable, theoretically, which accomplished the same result. This was unfortunate for the maker of the older object-glass, who was an unpretending man, because he had, as thus related, constructed, but was never publicly credited with constructing, the first objective which showed these fine markings; and it was unfortunate for the microscopist, also, because practical investigation might have saved him eighteen months of time spent in theorizing.

Inexpressibly sad was the fate of another American microscopist who lived before the time of immersion-objectives. He was a searcher for diatom markings—

a determined seeker after the shadowy tracery supposed to exist in the filmy *Amphipleura pellucida*. He was a physician; but the infatuation of staring through his microscope, in a vain effort to "resolve" this misty diatom, gradually absorbed all his time, destroyed his practice, and so encroached upon his means that he became poor. Finally, his one-tenth-inch objective, by Spencer, became the substitute for his best suit of clothes. A fifteenth, and then a twentieth objective, by Wales took the place of his pawned gold repeater and auction-sold library. His shining silk hat and his sleeve-buttons were forsaken for a slouch "Derby" and an achromatic condenser. He wore a shirt two days to save washing bills in order to obtain an Abraham's prism, and he starved himself on cheap victuals that he might buy a second prism for an additional ray of oblique light. He neglected his friends, who never saw him when his head was not bent over the microscope. Weaker and weaker he grew in his wild chase after the phantom lines, till death overtook him one night as he sat in his barren room, surrounded by glittering brass tubes and flashing accessories, and his last breath was spent in a feeble attempt to whisper faintly: "Wider angle."

O. C.

[For the information of those readers who may not be quite willing to credit the story as related by our correspondent, we may say that there is "more truth than fiction" in it, as a number of New Yorkers well know.—ED.]

MICROSCOPICAL SOCIETIES

Since our last issue, the ELMIRA Microscopical Society gave its first annual soirée, on April 20th, for which great preparations were made. We are indebted to both Dr. Gleason, the President, and Dr. Up de Graff for complimentary tickets. We have no doubt the occasion was very enjoyable, and we very much regretted our inability to be present.

At the CAMDEN Microscopical Society, Prof. C. H. Kain discussed the subject of photomicrography, on the evening of April 6th. We have already printed a summary of his remarks on that subject, but one point of importance was omitted in the published article, which is that the dry-plates are quite sensitive to yellow light, and are therefore peculiarly adapted to such work. Two photographs were taken at the meeting, with excellent result.

At a meeting of the NEW YORK Microscopical Society held on April 7th, Mr. Hitchcock spoke on the genetic relations of fresh-water algæ. The substance of his remarks will be published next month. Some specimens of algæ were exhibited, among them *Coleochæte scutata* and a fine specimen of *Œdogonium Boscii* in fruit. Some other objects of interest were also shown.

At the meeting of April 21st, the subject of illumination was to have been discussed, but so much time was taken up by remarks about some objects which were brought for exhibition, that the subject for the evening was laid over for one month. Mr. E. G. Day exhibited a Zeiss' objective, ranging in power from a 2-inch to a 4-inch, the magnification being changed by turning the collar. Mr. Warnock showed *A. pellucida* with a Tolles 1-6-inch homogeneous-immersion objective, having a prism set in the objective for illumination from above. This objective was the first homogeneous-immersion to which the prism illuminator had been applied. The diatom was well shown, the lines being very well defined. Mr. Braman showed the *Protococcus nivalis*, or "red snow." Mr. Van Brunt stated that he had found an alga in snow at Poughkeepsie, N. Y., which seemed identical with the red snow. He mounted some of the cells, but they had all turned green. A number of other objects were shown.

At a meeting held May 5th, the subject of photomicrography was discussed, and a negative was prepared at the meeting.

Dr. Younghusband recently delivered a lecture on the subject of Biology before the Chautauqua Circle, of Detroit. At the close of the lecture, a number of objects were shown under the microscope, illustrating points brought out in the discourse. Among the many objects shown were the circulation of the blood in a frog's foot, exhibited by Elmer Willyoung; the growth of the yeast plant, by Preston Hickey; the circulation of the blood in the tail of a fish, by Wm. Younghusband. Mr. Reynolds showed the eels in sour paste, and many other interesting slides. Among the other objects, and the ones that probably attracted the most attention, were the circulation of the protoplasm in chara, exhibited by Mr. Duncan, and the amœba, by Mr. Lapham.

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Glass Cells.

BY C. HENRY KAIN.

Much has been said and written within the past year or two in regard to the proper material for cells, but in all the discussion I have noticed that very little mention is made of glass cells. For many purposes, especially for balsam or liquid mounts, they are preferable to all others, but their cost prevents their general use—a dollar a dozen being the usual price. I think if microscopists in general knew how easily they can be punched from glass covers, they would come into almost universal favor for shallow mounts. Their cost is trifling, as the cheaper grades of covers can be used, also those which would otherwise be thrown aside on account of some flaw or impurity in the centre.

The following is the method of preparation: Take a brass plate, say five inches long, one inch wide, and a quarter of an inch thick. Have a number of holes drilled (not punched) in it about an inch apart, and of various diameters corresponding to the diameters of the desired cells. See that in drilling these holes the shoulders are left perfectly square and sharp, but not burred. This is important, as the question of success or failure largely depends upon it. The plate having been thus prepared, heat it until it is sufficiently hot to melt a piece of sheet-wax placed upon it. Then place over each hole a disk of sheet-wax somewhat larger than the hole, and drop upon it a glass cover. The cover should be from $\frac{3}{16}$ of an inch to $\frac{1}{4}$ of an inch larger in diameter than the hole. Press the cover down so as to bring it in close contact with the metal plate, then set the plates away to cool. When perfectly cold take an ordinary sixpenny or eightpenny nail, boldly thrust it through the glass cover from the upper side, and rasp it round and round, always with a downward motion, until the cell appears perfectly circular. When all the covers upon the plate have been thus treated, reheat the plate so as to loosen the cells, throw them into benzine to dissolve the wax, let them remain a few minutes, then wipe them and put them away for use.

The method given is simple, but when describing it I have sometimes been met with an incredulous smile, as the idea of punching holes in glass with an ordinary eightpenny nail seems so ridiculous. Nevertheless it is a successful method; and, furthermore, if the directions given are carefully followed, not one cover in twenty need be spoiled in the process. Try it.

[We have received some of the cells made by Prof. Kain by the method described above, but they were broken in the mail. Judging from the fragments, they were perfectly good cells for any and all purposes. If we are not mistaken, Dr. L. Beale describes a method quite similar, somewhere in his book on the microscope.—ED.]

——o——

Rotifer Nests.

Exploring ponds in the low grounds along Paxton creek, flowing through the eastern suburbs of the City of Harrisburgh, Pa., April 15th last, I

was interested to find, besides a variety of species of *Spirogyra*, as *decimina*, *fusco-atra*, and *Hantzschii*, all in good fruiting condition, masses of *Vaucheria geminata*. On the filaments of this plant, nests of rotifers are of frequent occurrence. They appear as urn-shaped excrescences, cylindrical cells, outgrowths of the plant, somewhat swollen below the middle, contracted at the base, and distended at the truncate apex. Some are at the ends of the branchlets, eight to ten times the diameter of the branch, others grow out of the sides of the larger filaments; they measure 200 mm. to 350 mm. in diameter, about three times the thickness of the plant. In many of them the animals are seen, usually in motion in the lower part of the cells; all the cells contain many dull, rose-colored eggs. The cells are abnormal to the plant, and are probably produced by a sting or other irritation. Nest of this kind are unusual in my observations. I have seen the creature carrying its eggs; have found rotifer eggs in vaucheria plants and know them to have occurred in the leaves of *Sphagnum* (bog-moss), but have not known their power to produce such uniform outgrowths for nests.

F. WOLLE.

—o—

A Remarkable New Rotifer.

BY S. A. FORBES.

In a neglected aquarium in the Natural History Laboratory at Normal, Ill., the glass became covered with a coating of algæ, among which swarmed stentors and several species of rotifers. The largest and most abundant of the latter is of a character so peculiar and remarkable as to merit description.

GENUS *Cupelopagis*,* *gen. nov.*

Footless, eyeless, without carapace, and totally destitute of cilia or other vibratile structures, or locomotor organs of any kind. The trochal disk has the form of a large, oblique cup, which can be either retracted wholly, or pushed up by a constriction of its wide mouth. In the bottom of this cup is the oral aperture, which opens into a very large, loose crop, at the bottom of which, and usually behind the middle of the body, is the mastax. The jaws, which project into the

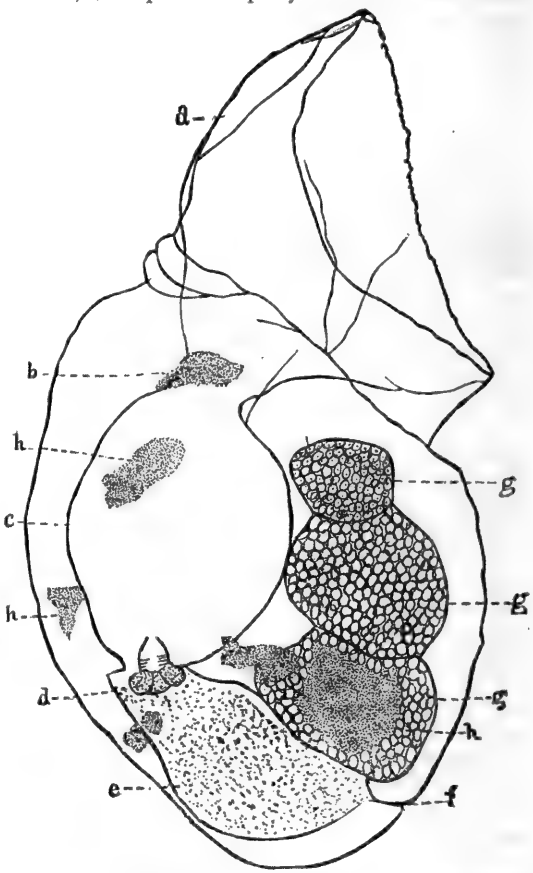

FIG. 32.—*Cupelopagis bucineda.x*, lateral view X 265. Drawn with camera lucida.
a, cup; *b*, œsophagus; *c*, crop; *d*, mastax; *e*, stomach; *f*, vent; *g*, embryos; *h*, problematical, black, or dark-brown bodies, irregular in form and position, situated in the perivisceral cavity.

* *Κυπελλον* and *παγτς*.

crop, are composed of two sharp, slender hooks, with about four slender, straight teeth at the inner base.

The stomach is large, and the intestine very small and short, opening on the ventral surface of the body near the posterior end.

C. bucinedax, sp. nov. The body is a coriaceous, flattened sac, minutely roughened over the whole surface, nearly as broad as long, and about three-fourths as thick. The dorsal outline is longest and strongly convex, the ventral being usually somewhat concave. The cup is oblique, the ventral height being little more than half the dorsal. Its lower wall usually presents a shallow, longitudinal concavity, so that the aperture is slightly kidney-shaped. The surface of the cup is more delicately roughened than the body, and its edge is minutely erose.

In an average specimen the length of the body, without the cup, was 0.16-in., and its width 0.014-in.

This rotifer has no means of attracting its prey or bringing it within reach, but depends wholly on such animals as chance to swim into its oval cup. When a stentor or other animalcule of considerable size enters the trap, the rotifer quickly puckers up the aperture and contracts the walls of the cup upon it, until it is forced, with a sudden slip, into the ample cavity of the pharynx. This apparatus enables it to secure much larger prey than the usual ciliated structure; but, in the absence of locomotor organs, it can only live in water swarming with suitable food. In the aquarium mentioned it was living almost wholly on the large stentors.

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Measurement of the Power of Oculars.

Mr. W. H. Bulloch has devised a simple apparatus for measuring the magnifying power of oculars, which is illustrated in fig. 33. It consists of an ordinary microscope with an ob-

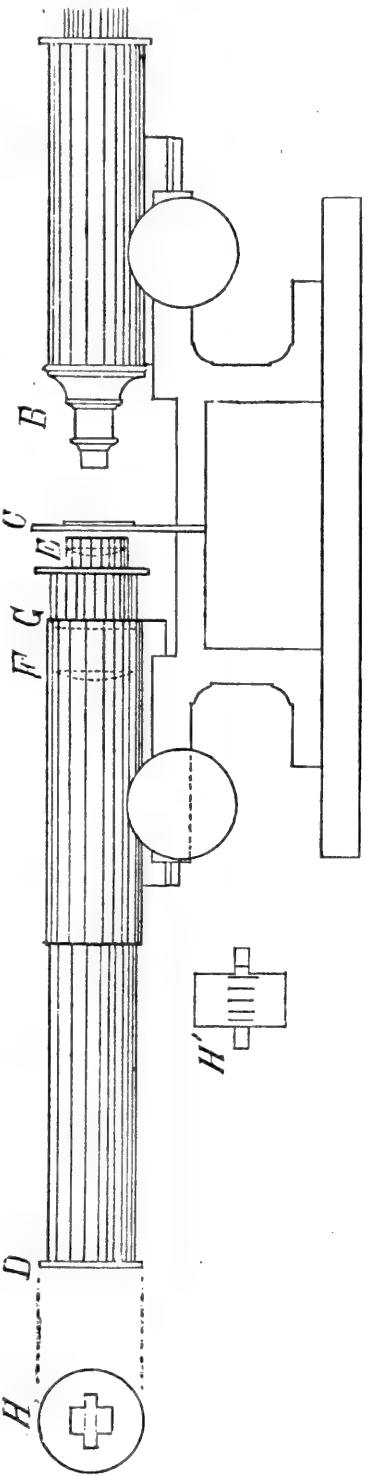

FIG. 33.

jective of two inches equivalent focus, which, in practice, is the most satisfactory power for the purpose. This microscope is used to examine an image of a diaphragm, formed by the ocular to be measured. The exact size of the diaphragm and its distance from the ocular being known, the size of the miniature image formed by the ocular can be readily measured, and a simple calculation then gives the magnifying power.

In the figure, *AB* represents the examining microscope; *C* is a stationary stage having a micrometer ruled in lines 0.1 mm. apart. The tube with draw-tube, *GD*, carries the ocular to be tested at *G*, and the diaphragm of known size at *D*. The shape of the diaphragm-opening is shown at *H*, *H'*. By means of the draw-tube the distance *GD* can be changed, but it is usually made ten inches from the diaphragm of the ocular to the end of the tube. The width of the aperture at *D*, in the instrument used by Mr. Bulloch, is 6.5 mm. Directing the instrument toward the light, an image of the aperture will be formed by the ocular, and can be focussed upon the micrometer at *C*. Then the size of the image can be read off in the microscope, and the difference between the size of the image and the actual size of the diaphragm indicates the power of the ocular. Suppose the image just covers eleven divisions on the micrometer, the distance being ten inches as above, then 65 divided by 11 is about 6, which is the magnifying power in diameters.

A Bausch & Lomb periscopic oculer "C," measured in this way gave a power of 11 diameters; a Tolles ½-inch solid, 16½, and a Gundlach ¼-inch, 43.

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Pollen-tubes.

About half a century ago, Amici observed that the pollen-grains produced tubular appendices by the absorption of moisture on the stigma, and came to the conclusion that these tubes descended from the stigma through the style to the placenta. Several other writers after him made the same observation, and further, brought the pollen-tubes in connection with the process of fertilization of the ovules.

M. Brogniart was of the opinion that the pollen-tubes, after a shorter or longer penetration into the stigmatic tissues, expand on the accumulation in them of the contents of the pollen-grains, that the membrane of the tubes bursts, and the fovilla is thus scattered amongst the papillæ of the stigma.

M. Tulasne stated, in 1849, that he had seen the end of the pollen-tube come in contact with the membranes of the embryo-sac, without producing there a depression or a strong adhesion.

The theory of the fertilization of the ovules by means of the tubular appendices of the pollen-grains descending through the style to the ovarian cavity, and thence seeking their way to the foramen of the ovules, is now universally adopted by authors, and, as it appears, mostly without personal examination or observation; some of them attempt to explain the manner in which the pollen-tubes overcome the difficulties they find in their way towards the foramen. Lindley, in speaking of the fructification of the orthotropous ovules of the rockrose, states, on the authority of M. Brogniart, that the pollen-tube does not follow the placenta till it reaches the ovule, but quits the style at the top of the cavity of each cell, and thence lengthens in the open space inside the ovary till it reaches the foramen in the end of the ovules. Mr. Detmar has published more recently also a paper on the "Course of the Pollen-tubes," a synopsis of which was published in the April number of 1881 of the *Journal of the Royal Microscopical Society*, of London. I followed his description, having preparations of the ovaries of most of the

plants he describes in my cabinet; his descriptions are correct, but I failed to detect any pollen-tubes on their way to the foramen.

I am at a loss to account for my inability, after having dissected hundreds of ovaries in various stages of development, to observe in a single instance the entrance of a pollen-tube into the micropyle; for some time I attributed it to a want of skill in preparing my sections, but since I have had an opportunity to compare my preparations with some which, it is said, Hofmeister used as a basis for his descriptions, I came to the conclusion that this was not the cause: it must be sought for somewhere else. At all events, it seems that the entrance of the pollen-tube into the foramen has been only observed in a few plants. Schacht, in his works, mentions: *Canna*, *Viscum*, *Najas*, *Passiflora*, and some geraniaceæ. I have examined these plants. In most of them the tubular appendices of the pollen-grains on the stigma are easily observable, but very soon they appear to discharge their contents in the conducting tissues of the style, and lose their existence as tubes.

My observations on cactaceæ led me to believe that here I might meet with success, but I was disappointed again. I made a phyllocactus, commonly called "crab cactus," the subject of particular study, and as a result of my observations, I venture the following statement:

The pollen-tubes insinuate themselves amongst the papillæ of the stigma where, on bursting, the fovilla is taken up by the conducting tissue of the style. This tissue is composed of very fine fibrillæ, full of granular matter, whilst the process of fertilization is going on. At the base of the style, it spreads itself out over the walls of the ovary; it accompanies the vascular bundles in the funiculii from the placenta, up to their juncture with the ovules. The tuft of papillæ surrounding the micropyle of the anatropous ovule meets near the placenta the tuft of the conducting tissue of the funiculus, where the papillæ of the former absorbs, by endosmosis, the granular contents of the latter, and in this way I conceive that fertilization takes place.

In the closed flower-bud of the same species of cactus, the stigma, as a matter of course, is yet free from pollen-grains and their appendices, but the conducting tissue is present in the style; it contains already a number of granules, different however from the granular matter present in the conducting tissue during the process of fertilization.

The observations on "crab cactus" furnished me the data for a new theory of fertilization, and *Cereus grandiflora* (night-blooming cereus) furnishes data to arithmetically demonstrate the impossibility of fertilization of the vegetable ovules taking place, in the cactaceæ at least, according to the old one.

The specimen under investigation, gave the following data:—

Length of style, 9 inches (a hollow tube $\frac{1}{10}$-inch in diameter).

Ovarian cavity, a cylinder $\frac{2}{10}$-inch in diameter, and over one inch in height.

I made about forty transverse sections of the ovary, sufficiently thin to count 100 to the inch. Each section contained about thirty ovules, of which the greater number, however, floated off the knife, the funicules having been cut; the number of ovules in the ovary, would thus amount to at least 3,000.

The style, in transverse sections, shows a ring of eighteen vascular bundles corresponding to the eighteen divisions of the stigma. Inside this ring is contained the conducting tissue, forming a hollow tube, the nature and compactness of which precludes the possibility of giving passage to 3,000 pollen-tubes. In the ovarian cavity there is also no room for 3,000 pollen-tubes, after they should have descend-

ed to the ovary, to grope about in search of the micropyle of the ovules; at all events, as thus only few of the tubes could come in contact with the micropyle, the chance would be that the greater number would remain unfertilized. Nature leaves nothing to chance; it has provided simple and certain means for the fertilization of all the ovules in the ovary. The anatropous ovules are fertilized by their inversion on the funicules, bringing the papillæ of the micropyle in contact with the papillæ of the former. Campylotropous and amphitropous ovules come often in contact with the funiculus or with the papillæ of the walls or septa of the ovary, according to the length of the funiculus. The orthotropous ovules are fertilized in the same manner.

The orthotropous ovules of the coniferæ, are fertilized by the pollen falling directly on them, which is an old observed fact.

Not having had the advantage of personal instruction by professors of the science to which I am devoted merely as an amateur, it occurred to me, some time ago, that perhaps the fine fibrillæ of the conducting tissue in the style might be the pollen-tubes of the authors. I applied for information at headquarters, but I have not been favored with a reply; I should be glad to receive the desired information from anyone who may be able to give it.

J. KRUTTSCHNITT.

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Abstract of the Address of the President of the Royal Microscopical Society, London.

PROF. P. MARTIN DUNCAN, M. B., LOND., F. R. S., ETC.

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When we consider, moreover, the large number of observations recorded the past year by the various Societies, which receive communications principally worked out by means of the microscope, it cannot fail to be recognized that the activity and progress of microscopy are greater now that at any former time, and that the tendency is to still further increase. The most valuable part of our bimonthly Journal, is the summary which it contains of this stupendous amount of o riginal work. The microscope is, moreover, being carried into new fields. It now promises to be of great assistance to the chemist, and while but a few years ago no one thought of including it among the essential tools of the geologist, it is extensively applied at the present time to the examination of rocks, and most valuable results have been brought to light by its aid. Instead then of allowing ourselves to be tempted to bemoan the "stagnation of microscopy" we, as a Society devoted to its study, may congratulate ourselves and the rest of the scientific world, that whether as regards theory or practice—the optical and mechanical or the observational part of our science—there has never been a time when so much evidence could be produced of solid progress as now.

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THE ABBE THEORY OF MICROSCOPICAL VISION.—Although those views are now several years old, and were brought before the Society so long ago as 1877, by our then Treasurer, Mr. J. W. Stephenson, the recognition of the extraordinary nature of the experiments, was, until lately, confined to a very small circle. Both in this country and in Germany and America, however, the past year has seen a great extension in the number of those who have followed these experiments, and who have appreciated the important bearing which they have on microscopical vision.

I have used the term "extraordinary," because I think that every one who has seen these experiments will readily agree that it is extraordinary, in every sense of the word, to find, that merely by excluding a greater or less number of the "diffraction" images found at the back of the ob-

jective, a great variety of entirely different appearances are presented by one and the same object—lines at a known distance apart, doubled and quadrupled,—or that objects in reality quite unlike can be made to seem identical—multi-sided figures giving images of squares. In short, the same objects may appear to be different in structure, and different objects may seem to be identical entirely according as their diffraction images are made dissimilar or similar by artificial appliances between the objective and eye-piece. The appearance of particular structure can even be predicted by the mathematician, before it has been actually seen by the microscopist.

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Our veteran microscopist, Dr. Carpenter, C. B., has embodied, in the edition of his widely known work published during 1881, a statement of the leading points of the diffraction theory, which is valuable as containing the results of his own matured views on the subject. He says (p. 187), "This doctrine, originally based on "elaborate theoretical investigations "in connection with the undulatory "theory of light, has been so fully "borne out by experimental inquiries "instituted to test it, and is in such "complete harmony with the most "certain experiences of microscopists, "that its truth scarcely admits of a "doubt."

There are one or two points that require to be kept prominently in mind in regard to the diffraction phenomena in question; 1st, that they are not to be confounded with the so-called "diffraction band" observed round the outlines of objects illuminated by oblique light, nor with the "diffraction rings" displayed by brilliantly illuminated globules; 2d, that they are not confined to transparent objects illuminated by transmitted light, but are also produced by opaque objects; and 3d, that they are not limited to lined or regular objects, but extend also to irregular structures, or isolated elements of any shape; in fact, universally to structures of all kinds, whenever the uniform propagation of the luminous waves is disturbed by the interposition either of opaque or semi-opaque elements, or of transparent elements of unequal refraction, which give rise to unequal retardations of the waves. They therefore apply not merely to the "resolving power" of objectives, but to their general delineating power—the power of the Microscope to show things "as they are."

The third point is, I need hardly say, most important, and one which it will be very interesting to have more fully elucidated, having regard to Professor Abbe's statement that objects (such as the flagella of bacteria) which are only a fraction of a wave-length in diameter, will necessarily appear to us, not in their proper proportions, but with greatly increased diameters, and that very minute striations must appear as if the dark and bright interspaces were nearly of equal breadth, although in reality not so.

There are obviously many histological problems, such as the question of the structure of muscle, which a proper knowledge of this part of the subject may greatly help to elucidate.

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The Aperture of Objectives.—The essential difference between the old and the new view of aperture is simply, that the former considered only the rays which enter the objective, while the latter deals with those which emerge from it.

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An estimation of the emergent beam, however, must obviously give the same result as one of the incident beam (assuming them both to be correctly made), it being of course impossible for anything to emerge that has not first been admitted. But to quote Mr. Crisp:—"The great and obvious advantage in dealing with the emergent pencil is that it is always in air, and so the perplexities are

eliminated which have enveloped the consideration of the admitted pencil, which may be in air, water, oil, or other substances of various refractive indices."

The subject of aperture is not, in reality, a difficult one, and any intricacy in which it may seem to be involved will be found to arise from the necessity of clearing away some of the old entanglements, such as the curious mistake involved in the "hemisphere puzzle" and similar matters. Looked at *de novo*, there are two simple stages in the aperture question.

(1) To appreciate that, in using the term "aperture," we use it not in any artificial sense, but as meaning opening and nothing else,—defining, simply, the capacity of an objective for receiving rays from the object and transmitting them to the image.

(2) That the aperture (as so defined) of an objective is determined by the ratio between the diameter of the emergent beam and the focal length of the objective. According as this ratio is greater or less, so the objective will receive and transmit a larger or smaller portion of the total quantity of rays presented to it.

The emergent beam of an air-objective of 180° angle cannot exceed in diameter twice the focal length; that of a similar water-immersion objective may be one-third larger, and of an oil-immersion half as large again, and the relative capacities of such objectives (with equal angles) to receive and transmit rays will always be as 1, 1⅓ and 1½.

It cannot be too carefully borne in mind that it is not a question of this or that theory, but the ordinary laws of geometrical optics which determine that, all other things being equal, one objective will receive and transmit a greater quantity of light than another, and therefore has the larger or smaller aperture, according as the diameter of the beam emerging from it is greater or smaller.

As Fellows of this Society we may, I think, be proud of the able communications relating to this subject, which were published in the April and June numbers of the journal.

Numerical Aperture. — The abandonment of the angular notation for aperture necessarily follows, as soon as the correct view of aperture is appreciated; for when we know that the apertures of three objectives are, for instance, as 98, 126, and 138, no one would insist that they should be designated 157°, 142°, and 130°. A notation can have no title to be considered a scientific one, which denotes things as the same when they are really different (60° in air and oil) or different when they are the same (180° in air and 82° in oil).

Until, however, the "law of aplanatic convergence" had been demonstrated by Professor Abbe, no principle had been established by which the ratio between emergent beam and focal length, could be conveniently denoted.

It would not be possible for me to condense, without a sacrifice of intelligibility, the steps by which he subsequently showed, in a very beautiful manner, that the ratio in question can be expressed by the product of the refractive index of the medium in front of the objective, and the sine of half the angle of aperture, that is, by $n \sin. u$.

Taking for our unit the capacity of an objective for collecting the whole hemisphere of rays from an object in air (*i. e.* the case of a dry objective of 180° angle) we obtain the "numerical" notation, which, commencing with the lowest numbers advances as far as 1.52 with oil-immersion objectives, and by the use of which not only are apertures compared in the same medium, but in different media also, and we see whether they are smaller or larger than the maximum of a dry objective.

It is gratifying to find that reproach hitherto attaching to microscopists for the use of a misleading notation, is, thanks to the efforts of this Society, being rapidly removed, and that

the initials N. A. are no longer so mystic a symbol as they have been. I understand that many of the opticians have decided to use the numerical notation in the future issues of their catalogues, which is a step in the right direction, which we shall hope to see generally followed.

Whilst on this subject I may point out how important it is that in observations with high-power objectives, their aperture as well as magnifying power should be stated. Whether a large or a small aperture has been used, may make a very material difference in the value to be attached to the results described.

THE "HOMOGENEOUS IMMERSION" PRINCIPLE. — The utility of homogeneous-immersion objectives being established beyond doubt by practical experience, it is interesting to note that the origin of the principle is very fully recognized by Professor Abbe to be due to our esteemed Fellow, Mr. J. W. Stephenson.

The two essential points in homogeneous-immersion are, 1st, the increase in aperture obtained by the use of a fluid of high refractive index, and 2d, the enhanced optical performance arising from the total suppression of spherical aberration in front of the objective. Professor Abbe states that although Amici first applied oil-immersion, he failed to recognize the specific advantage of an immersion fluid being as near as possible in refractive and dispersive powers to the crown glass (i. e. "homogeneous"). He finished his lenses and then sought for oils and mixtures of oils of various refractive powers for obtaining the best correction. "It was Mr. Stephenson who, in his first communications with me, expressed the opinion that doing away with the anterior aberration would improve the defining power, and especially would afford very favorable conditions for further increase of aperture."

The importance of this system will be appreciated when we remember, in regard to the first point (the increase of aperture), that the theoretical resolving power of an objective is thereby raised from 96,400 lines to an inch, which is the maximum of a dry objective, to 146,528 the maximum of an oil-immersion objective, the illuminating power being also increased from 1 to 2.25: while as regards the second point, we are able, by the homogeneous-immersion method, to reduce the problem of correcting a very wide-angled objective to the much less difficult one of correcting an objective of moderate air-angle. Our lamented President, the Rev. J. B. Reade, declared in 1870 that "the ghost of aberration will never be entirely exorcised even by cold water." But there appears to be good ground for believing that oil has practically accomplished that object.

* * * * * * *

Lastly must be noted an important advance in practical manufacture by the construction, by Messrs. Powell and Lealand, of a homogeneous-immersion objective of the large aperture of 1.47 N. A. out of a possible 1.52. As long ago as 1850, one of my predecessors in this chair, expressed the belief that objectives had then "nearly, if not quite, attained the limit of perfection," and whilst it will be prudent even at this much later date to avoid any assertion of finality in the present, or scepticism as to the possibilities of the future, it must be admitted that, so far as regards aperture and resolving power, we have arrived at a point beyond which it will, to all appearances, be difficult to advance, at any rate not without serious restrictions in the use of the objectives. Whilst it might be possible to work front lenses for objectives out of diamond, and so to increase the aperture to 2.5 N. A., and the resolving power to 241,000 lines to the inch, it must be remembered that it would be essential at the same time to provide an immersion fluid, slides, cover-glasses, and

illuminators of the same refractive index as diamond also.

PENETRATING POWER OF OBJECTIVES—DEPTH OF VISION. — This again is a subject which has long been obscure; very various opinions being held as to the true nature of what has been generally termed the "penetrating power" of an objective. By some it has been declared to be a defect in the construction of the objective—residual, uncorrected, spherical aberration in fact; and by others as necessarily inconsistent with perfect definition, even with the best methods of construction; the only approximately correct notion regarding it, being that it decreased as the angle of aperture increased.

Professor Abbe, however, in a very valuable paper, placed the question on the scientific basis so long needed showing that the total depth of vision in the microscope, *i. e.* the solid space which at one focus of the microscope is visible with sufficient distinctness, depends not merely on the depth of focus of the objective, but is the sum of that and the depth of accommodation by the eye.

The depth of focus (other conditions remaining the same) varies in inverse ratio to the magnifying power, and also to the numerical aperture of the objective. Thus with a ¼-inch and ⅛-inch of the same aperture the depth of focus of the former would be twice that of the latter, or if the powers are the same but the apertures are .50 N. A. and 1.50 N. A., it would be as 2 to .66.

The depth of accommodation depends upon a point which was entirely new to microscopists until developed by Professor Abbe, *viz.*, the peculiar property of microscopical amplification, by virtue of which the linear amplification of the depth of an object is largely exaggerated, being equal to the square of the linear amplification laterally. Thus an object magnified, according to ordinary parlance, 100 linear diameters (*i. e.* in breath) is magnified 10,000 linear diameters in depth. Now the depth of accommodation varies in inverse ratio to this depth-amplification, that is, inversely to the square of the magnifying power, so that whilst large with the low powers, it decreases very rapidly and disproportionately as the power is increased.

The joint effect, therefore, of the diminution in the depth of focus and depth of accommodation is that the total depth of microscopical vision diminishes, not in the same ratio as the increase in the magnifying power, but at first in a much greater ratio. With the low power we have considerable depth of vision, as it is then chiefly influenced by the large accommodation-depth. As we proceed to the medium powers (100–300) the accommodation-depth very rapidly diminishes, and becomes equal to that of the small depth of focus, so that the total depth of vision is necessarily small also. As the power is further increased, the accommodation-depth ceases to have any influence, and the depth of vision becomes principally depth of focus only. If, for instance, an amplification of 30 times is increased to 300, the depth is reduced not to $\frac{1}{10}$ but to only $\frac{1}{100}$ of its original amount; or, taking the depth of vision with a power of 10 times to be 2mm., with powers of 30, 100, 300, 1000, and 3000, it is only .254, .0273, .0047, .00094, and .00026 mm.

The formula

$$\text{Depth of vision} = n\left(\frac{L^2}{N^2}\lambda + \frac{L\omega}{N\alpha}\right)$$

shows at once how much the depth of vision may vary by a change in the conditions—represented by the various factors in the formula—which make up the total effect, important among which, as will be seen from the form of the equation, is the refractive index, n, of the medium in which the object is mounted.

MICRO-STEREOSCOPIC VISION. — The determination of the depth of vision (in monocular observation)

naturally throws great light also on the conditions for effective-micro-stereoscopic vision. It is obviously only when an object can be completely seen in all three dimensions at one adjustment of the focus, that a true stereoscopic image of it can be obtained. So long as only a single layer of inappreciable depth is visible simultaneously with any distinctness, no stereoscopic apparatus, however perfect, can bring into view the form of the whole of the object.

Now, with low powers we have large visual depth, so that objects of considerable thickness can be seen as solids. By reason, however, of the rapid decrease of the depth of vision to which I have referred, the thickness of the objects which can be seen in relief, rapidly and disproportionately decreases as the power is increased, so that only very thin objects are suitable with even the medium powers, the absolute depth, in the case of an object magnified 300 times, not amounting to a hundredth of a millimetre. With still higher powers the images of solid objects (though the decrease in depth is no longer so irregular) necessarily approach more and more to simple plane sections, the absolute depth with a power of 1,000 times amounting only to a micromillimetre. For medium and high powers, therefore, the only objects suitable for the stereoscopic binocular, are those which present, within a small depth, a sufficiently characteristic structure, that is, which have sufficient salient points for stereoscopic effect. We can, however, increase the depth of vision by using narrow illuminating pencils, and by mounting the objects in some highly refractive substance. The above considerations also show the importance of using the lowest power sufficient to recognize the object.

Whilst the reduction in depth limits effective stereoscopic observation, Professor Abbe properly points out that there is a compensating advantage in ordinary microscopic observation, in that as the depth-perspective becomes more flattened the images of different planes stand out from each other with still greater distinctness, so that "with an increase of amplification the microscope acquires more and more the property of an optical microtome, which presents to the observer's eye sections of the object, of a fineness and sharpness that no instrument could produce by mechanical means."

Another novel point was the demonstration of the very material distinction between ordinary stereoscopic vision and that with the microscope. The perspective shortening of the lines and surfaces by oblique projection, which is an important element of solid vision with the naked eye, is wholly wanting in microscopical vision, in which we have only the other element, a relative displacement of successive layers in the image. That these displacements are seen in the microscope, depends entirely on the peculiar exaggeration in the amplification of the depth of an object which is not found in ordinary vision.

The paper "On the Conditions of Orthoscopic and Pseudoscopic Effects in the Binocular Microscope" is also a most useful contribution to the theory of micro-stereoscopic vision, establishing, as it does, the true criteria for both classes of effects, and at the same time clearing up a misconception that had arisen as to the supposed necessity for the rays from the two halves of the objective crossing in order to get proper orthoscopic effect. If the delineating pencils have been reflected an even number of times in the same plane, the rays must cross, but otherwise not.

(*To be continued.*)

The Preparation of Diatoms.

BY R. S. WARREN, M. D.

Directions for the preparation of diatoms are rather meagre in books.

Those given by Pritchard; Dr. A. Mead Edwards in his work on the "Natural History of the Diatomaceæ;" Dr. Christopher Johnson, of Baltimore, in the *Lens*, Oct, 1872, and others, are good as far as they go. Cleaning is effectually accomplished by their processes, but their directions for the separation of the diatoms from the sand and broken diatoms are insufficient.

The process of preparing diatoms is simple, but requires great care, time, and patience. When the gathering is pure, as in filaments, or on algæ, the process is easy; but when the gathering is in the mud of rivers, lakes, and ponds, or in the mud of marshes and harbors, in which there is more or less organic matter, and in lacustrine (sub-peat), sedimentary, sub-plutonic and fossil deposits, it is generally toilsome, tedious, and often difficult.

The chemicals used are carbonate of soda, liquor potassa, muriatic, nitric and sulphuric acids, bichromate of potash, chlorate of potash, and water of ammonia. The apparatus consists of glass beakers of various sizes, bottles, small and large, mostly wide-mouth, evaporating dishes, rubber tubing for syphons of one-eighth inch to one-quarter inch calibre, glass rods, or thick narrow strips of glass for stirring, glass slides, glass dipping tubes, filter-paper, funnels, and a chemist's retort-stand.

I have found the best commercial acids sufficiently good; if either need be chemically pure it should be the sulphuric. All the water used in the preparation of diatoms should be distilled or filtered, that there be no admixture of diatoms foreign to any material. For the same reason, the beakers, bottles and dipping tubes should be thoroughly cleansed after use, as diatoms will adhere to them unless great care is taken. I filter water through two thicknesses of druggists' filter paper, a piece of thin muslin being placed between them at the point of the filter to prevent easy rupture at that spot. Another desirable effect of filtering the water used, is that it is thus rid of much organic and other matter, and is made to practically answer the purposes of distilled water; besides, the latter is not easily obtained in large quantities, and is expensive. In this article, when water is mentioned, filtered water is to be understood.

The process of preparing diatoms varies somewhat according as the material may be mud, lacustrine, sedimentary, sub-plutonic, or fossil deposits. I will first describe the treatment of fresh, mud material, and will here say that many of my manipulations are derived from directions given by the authors above mentioned, but some are peculiarly my own.

Having a quantity of mud material, if in no haste I put it into a wide-mouth bottle, and wash it repeatedly, allowing sufficient time for the material to settle after each washing, until it finally settles, leaving the water nearly or quite clear. The time required for the material to settle depends upon the forms in it, the quantity, and the size of the bottle. This is ascertained by examining some of the unsettled portion taken from just above the deposit with a dipping tube. A few drops of this evaporated on a slide and examined under a microscope will tell whether it contains anything more than organic matter. In this way can be ascertained the time required for the material to settle before draining off the water. The draining is done with the rubber tube used as a syphon. Having thoroughly washed the material, it is boiled for a short time in a solution of carbonate of soda (washing soda), about an ounce to the pint of water, in a glass beaker, then washed as before, till all the alkaline odor and taste have disappeared. This boiling in a solution of carbonate of soda destroys considerable of the organic matter, and in a measure cleans the diatoms. I have sometimes used, very

carefully, with good effect, weak liquor potassa instead of carbonate of soda. The material is then ready for the acids. If in haste, I at once boil the material in a solution of carbonate of soda, or even dispense with this and treat it with the acids. But the washings and boiling in the solution of carbonate of soda remove a large quantity of organic matter and save acids.

When ready for the acids, I shake the material well in water, pour a certain quantity into a beaker, allow it to settle, and drain off the unsettled portion. I then add muriatic acid in about the following quantity: If the material occupies half an inch in depth, I add one-quarter to one-half an inch in depth of the acid. I then add one-third to one-half as much nitric acid, and stir the whole with a glass rod, or a strip of glass, when, placing the beaker on one of the rings of the retort-stand, on which has been fastened a piece of wire gauze to prevent the flame of the lamp from coming in direct contact with the beaker, the material is boiled for a few minutes, five perhaps, seldom ten, and while boiling, finely powdered chlorate of potash, or finely powdered bichromate of potash, is slowly added till effervescence nearly or quite ceases, but the quantity used is much a matter of judgment. A good deal of effervescence ensues, and the beaker may be overflowed if not closely watched. The acids dissolve the salts of lime and other substances which may be in the material, and the chlorate and bichromate of potash combined with the acids destroy the organic matter by oxidation. After it has cooled, the material is washed free of the acids and the water drained off. It is then boiled in sulphuric acid, using nearly the same quantity as of the mixture of muriatic and nitric acids. While boiling, chlorate of potash, or the bichromate of potash in fine powder, is slowly added. If bichromate of potash is used, a few drops of muriatic is added. Generally the material turns pretty white; sometimes it will not. As with muriatic and nitric acids, a good deal of effervescence ensues, and the same watchfulness is necessary. Never add chlorate of potash to cold sulphuric acid or there will be explosion. It is safe to carefully add it in fine powder to boiling sulphuric acid. I prefer chlorate of potash in the whole process. I will remark here in regard to the use of the acids, that I have used them in various ways. I have first boiled the material respectively in sulphuric, muriatic and nitric acids, and in combination, and I have settled upon the above process of first boiling it in a mixture of muriatic and nitric acids, and then in sulphuric acid; I have found this to answer with all material, whether mud, lacustrine, sedimentary, sub-plutonic, or fossil.

After the boiling in sulphuric acid, the material is transferred to a wide-mouth bottle and repeatedly washed. After the material is freed of the acid, the light, broken portion of the material will remain suspended in the water above the settled portion. This is drained off by means of the rubber tubing, water is added, the material is shaken, allowed to settle, the floating matter drained off, and this is repeated till nothing remains but diatoms mixed with sand. If, however, flocculent matter should remain, and this can be ascertained with the microscope, it may be broken up and disposed of by means of common water of ammonia—concentrated water of ammonia one part, water two parts, by measure—and further washing. The ammonia should be carefully used as there is danger of injuring delicate forms by its use. If, for instance, there be a quarter of an inch depth of material in an eight-ounce bottle, not more than half an ounce, by measure, of the ammonia should be used. The material is well shaken in this for three or four minutes, the bottle then filled with water and the washing continued till the

material is freed of all the flocculent matter. It is surprising, sometimes, to see the quantity of this.

We now have the diatoms mixed with fine sand. How are we to get rid of the latter? If there happens to be coarse sand in the fresh material, we may get rid of it by repeated settlings and decantations before boiling; and should some remain at the last washings after the boilings, it may be disposed of in the same way. But it is different with the fine sand. Graduated settlings and decantations have been advised; but these are insufficient, as, despite all care, more or less of light silt will float with the light forms of diatoms, and the heavy diatoms will fall to the bottom with the heavy sand. Whirling in an evaporating dish, has been advised, but this is insufficient. I have found no method better than the one I have used for several years, and which I have never seen described or hinted, except in regard to whirling. A few years ago, Mr. E. Samuels of Boston, Mass., told me he had used a method similar in some respects.

If the material contains the lighter forms only, I first use whirling force as follows: I take an evaporating dish of a size according to the quantity of material, and fasten it on the wheel of my turn-table by means of a narrow rubber band passed over it and under the wheel. The material is diffused in five or six times its bulk of water. An empty, wide-mouth bottle is near the turn-table and should have a capacity of two or three times the quantity of diffused material. Shaking the material well, I fill the evaporating dish about two-thirds, and then whirl it with considerable rapidity till I think the sand has mostly settled at the bottom of the dish, for the whirling motion causes it to fall. I then pour off the unsettled portion into the empty bottle and add more of the material to the sand and diatoms remaining in the dish, and stir with a narrow strip of glass, the whirling is repeated; and so on with all the material. When this has been done, water is added to the portion in the dish and the process continued till no diatoms remain in the sand. To ascertain this, the dipping-tube, again comes into use. The material is treated in this way several times, till no sand can be obtained by it. If the material contains heavy diatoms like the large pinnularias, *Triceratium favus*, and heavy disk-forms, the whirling process cannot well be used, for these heavy forms fall to the bottom of the dish with the sand.

After the above process is ended, I proceed as follows, and this is, in most cases, the only method used after the boiling and washings. I have a slide of polished glass 3½ inches by 4½ inches; a smooth block of wood 4 inches by 5 or 6 inches, and 3 inches thick; two wide-mouth bottles of four to six ounces capacity, with thin, projecting lips, one empty, the other filled with the material thinly diffused in water; several pieces of considerable size of old worn cotton cloth, and, for I like it best, a clean linen pocket-handkerchief, and a small table. The table I place beside my wash-bowl which is supplied with water—not filtered in this instance—through a pipe and faucet, and on it are arranged my bottles, block and cloths. I place the glass slide on the block, taking care that the latter is level, and, well shaking the material, pour a little of it on the slide, and then quickly pour it off, tipping the slide so that the material will flow off from a corner of it into the empty bottle. The diatoms float off into the bottle, and the sand adheres to the slide. The slide is then washed by letting water upon it from the faucet, then wiped as well as may be with one of the large pieces of cloth, and then the surface to be used is wiped with the linen handkerchief. This last wiping dries the surface thoroughly, and removes any little shreds of cotton, which may have

adhered to it from the cloth. Care is taken that none adhere. In this way the material is all worked over and this treatment has to be repeated perhaps many times before the material is sufficiently rid of the sand. It may be that before this is accomplished, the sand and diatoms will cling together on the slide, causing considerable loss of the latter. This is owing to little particles of matter getting into the material from the cloths, or from the air, and cannot be prevented. As soon as this clinging is detected, which is easily done by occasionally examining the slide under the microscope, first drying it after pouring off the material, the latter should be boiled for a minute in sulphuric acid, to which is added a little chlorate of potash while boiling. Of course the diffused material is poured into a beaker, allowed to settle, and the water drained off. It is then washed and the treatment continued. When the material is at last freed of sand. it is boiled a last time in sulphuric acid, chlorate of potash being used as before. It is then thoroughly washed and properly diffused in dilute alcohol for mounting. The alcohol should be filtered as well as the water.

In this last process some of the diatoms will adhere to the slide, but this is of little consequence if there be plenty of material. As the cloths get pretty wet, as they will, they should be exchanged for dry ones.

Such is the treatment of fresh-mud material. Lacustrine (sub-peat), sedimentary deposits and guano, are treated in the same way.

The treatment of hard, sub-plutonic and fossil material is somewhat different. This material is often very hard and has to be reduced to powder. This is accomplished by boiling it in a solution of caustic potash —liquor potassa. This should be cautiously used, as too much boiling in it will injure the diatoms. Boiling in a strong solution of carbonate of soda will often accomplish the same end, though not so easily, but its use is safe. As soon as a portion of the material has fallen in powder, it should be poured into a large quantity of water, and the remaining lumps boiled in the solution of potash or of carbonate of soda ; this is to be repeated till the whole has been reduced to powder. The treatment is then by acids, etc., as with fresh-mud material. Fresh-mud material should not be allowed to dry, as it is then very difficult to reduce it to powder. When dried hard, perhaps the best way is to first burn it in a crucible, or in an iron pan over a hot fire ; the organic matter will be pretty well burned out of it, and it is reduced to powder.

There are generally, I may say alalways, many broken diatoms in subplutonic and fossil material. It is very desirable to get rid of these. It may be accomplished in a great measure by using the slide as for getting rid of sand. The broken diatoms adhere by their rough edges to the surface of the glass, whilst the whole diatoms float off ; but more will be lost, perhaps, than when getting rid of sand in this way.

When the material is pure, as in filaments, or when attached to algæ, it is boiled in the acids, very gently if the forms are delicate. The action of the acids, chlorate and bichromate of potash, and the washings remove all organic matter and leave the diatoms pure.

COLORADO SPRINGS, Col.

EDITORIAL.

Subscriptions.—Remittances for subscriptions should be made by post-office, or express, money-order, by drafts payable in New York, or in registered letters. Money sent in any other way will be at the sender's risk. A receipt will be immediately given for money received by open mail.

—The sixth and last part of Saville Kent's "Manual of the Infusoria" will doubtless be issued in London by the time this JOURNAL reaches its readers, and will soon be in the hands

of subscribers in this country. The work will hereafter be supplied bound in cloth, in three volumes, two of text and one of plates.

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—We have received so many contributions for publication within the last few weeks that some of them must lie over for a month, and contributors should not be disappointed if their articles are not printed immediately. To ensure early publication, articles should be sent in as soon as possible. In most cases articles are used in the order of their receipt, but this rule is not strictly adhered to, for reasons that must be obvious to all readers.

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ADDRESS OF THE PRESIDENT OF THE ROYAL MICROSCOPICAL SOCIETY.—We regret that we cannot print this address in full, but there is so much original, interesting matter now in hand, that we have felt obliged to curtail the address somewhat. As a whole, it is one of the best, most clear, sensible and intelligible presidential addresses that it has been our good fortune to read for some time.

—o—

A NEW MEDIUM FOR MOUNTING.—The use of a solution of phosphorus in carbon disulphide was proposed long ago by Mr. Stephenson, of London, as a mounting medium for certain objects. The refractive index of this solution is 2.1. It is a liquid that requires considerable care in its preparation and use, and is, therefore, not likely to become very popular.

Another solution, with a somewhat lower refractive index, but one which has the advantage of being readily prepared, has been introduced by Mr. Stephenson. It is a solution of biniodide of mercury and iodide of potassium in water. It may be used of any strength, and the refractive index may be varied at will from 1.33, which is the same as water, up to 1.68, which is greater than that of monobromide of naphthaline. This fluid gives the microscopist an aquous medium which can be used instead of balsam or glycerin with equally good results, so far as the visibility of structures is concerned.

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POND-LIFE.—American microscopists in general need to be urged to devote more of their attention to pond-life. It is lamentable that so little is known of our microscopic fauna and flora, while in England the greatest interest seems to be felt in the study of living microscopic organisms. In the hope of stimulating our readers to give more time to collecting, we have printed several articles on collecting, describing what was found on one or two occasions, and once more we urge microscopists who have not time to collect for themselves, to order tubes regularly from Mr. Balen. We can assure them that they will get from him full value for their money. He has sent delicate living specimens across the continent to California, which have reached their destination in fine condition, and, in case they do fail to survive the journey he is always willing to send another tube free of charge. We hope he will he will be encouraged in his work of collecting and distributing specimens, by liberal orders from the country at large. Those who wish to see the beautiful *Volvox globator* in all its beauty, would do well to send to him for a supply. With the "Manual of the Infusoria," by Mr. Kent, the "Synopsis of Diatoms," by Dr. Van Heurck, the "Fresh-Water Rhizopods," by Prof. Leidy, or our own "Synopsis of Rhizopods" with plates, the collector would be well provided with books of reference; or with either one of these he could confine himself to a single subject, and study it to advantage. There is still wanting a good work in English on the algæ of fresh-water, and this we hope will eventually be written by Mr. Wolle.

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THE FLAGELLATES.—In the last number of the *Bulletin de la Sociéte*

Zoölogique de France, there is a Contribution to the Study of the Flagellates, by J. Künstler, illustrated by three plates, which deserves more than a passing notice. The author begins by a historical review of the study of these infusoria, which is very useful as well as interesting. He alludes to the different opinions that have been held by authors as to the position of these organisms in the scale of life, closing the chapter with the latest classification, that of Stein, which he seems inclined to adopt as the best.

The descriptive part follows, and in this chapter are recorded a number of new observations, which possess great interest, indicating that the author is a careful observer, and also demonstrating the superiority of the optical appliances of the present day over those used by observers in the past, for work of this kind. The organism most thoroughly studied in these researches, was similar to *Cryptomonas ovata*, Ehr. The attachment of the flagella was carefully examined. They are "inserted upon a fleshy cushion (*bourrelet charnu*) situated at the bottom of a tube which rises in the centre of the vestibulary cavity and surrounds these organs." A transverse striation, similar to that of muscles, was observed on the flagella, after treatment with reagents. Besides the terminal locomotor organs above mentioned, these creatures possess also another group of flagella which, owing to their extreme tenuity and transparency, have not been heretofore observed. These are situated in a series on the sides of the superior slope (*échancrure*) and are probably organs for the prehension of food. They are also to be found in other flagellates, as *Chilomonas*, *Cryptomonas* and others.

The body-covering of the animal presents a reticulated appearance, caused by the very regular distribution of grains of starch found in the inner portion of the tegument, which is made up of several distinct layers which are described. Passing hastily over this interesting part of the subject, some physiological considerations occupy the next few pages, but our notice is already quite long, and we can only translate an interesting passage, comparing certain process of animal and vegetable life :—

"The production of starch, in those organisms, does not seem to constitute a phenomenon absolutely dependent upon the function of the chlorophill, nor is it a direct consequence of it; because its intensity does not increase in a direct ratio with the abundance of light, but it is rather an immediate result of the second mode of nutrition which they possess, that which is exercised by the injection of food. In vegetables exposed to the light the chlorophyll corpuscles always contain one or several grains of starch; if they are placed in darkness, these granules disappear in a very short time, but others form after they are again placed in the light; the fabrication of the starch is in them, therefore, absolutely dependent upon the conditions of light.

"Among the *Cryptomonas*, on the contrary, when they find easily within reach nutritive material in abundance, this production of starch becomes so considerable that, by the continual thickening of the grains, these organisms finally become opaque, after which, if the food becomes more scarce, the production of starch diminishes progressively, and in a concomitant manner, until it ceases, however favorable may be the conditions of light, or however intense their green coloration."

We cannot do full justice to this most admirable memoir of original investigation, by any brief *résumé* that we might give here, but, so far as we have been able to judge, it is one of the most valuable contributions to this subject that has recently appeared.

NOTES.

—Mr. John W. Sidle has written a private letter to us concerning the use of the iris-diaphragm above the objective to reduce the angular aperture, in which he states that somewhere in the *Quarterly Journal of Microscopical Science*, or in the *Monthly Microscopical Journal*,

eight or ten years ago, Mr. Royston-Piggot described an apparatus which was nothing more than an iris-diaphragm, made by the Messrs. Beck, placed above the objective.

—In *The Northern Microscopist* Mr. J. B. Dancer has suggested a very simple plan of limiting the angular aperture of objectives by means of diaphragms. He cuts a shallow recess in the upper part of one of the female screw parts of a double nose-piece, into which the different diaphragms can be successively dropped, and lifted out with a wire hook.

—Dr. H. D. Schmidt, of New Orleans, in an article on the prevention of yellow fever, made the following declaration regarding aërial disinfection: "Aërial disinfection, as commonly practiced in the sick-room, is either useless or positively objectionable, owing to the false sense of security it is calculated to produce. To make the air of a room smell strongly of carbolic acid by scattering carbolic powder about the floor, or of chlorine, by placing a tray of chloride of lime in a corner is, so far as the destruction of the specific contagia is concerned, an utterly futile proceeding."

When we consider the power of the minute, so-called germs of disease to resist destruction by chemicals added to solutions in which they grow, it is surprising that so many physicians should place any value upon aërial disinfection in the sick-room. Surely, it may be reasonably concluded that an atmosphere sufficiently impregnated with gases or vapors to be destructive of the spores or germs of schizophytes, would also be poisonous to human beings.

—It is seldom that we hear anything about the notices under "Exchanges," and at times we have questioned whether our readers were deriving benefit from them. Dr. Ward's offer of pigeon-post despatches, however, has, we are sure, called forth many requests for those interesting photographs; and Mr. Cunningham, who has offered slides of *Biddulphia lævis*, informs us that he has received no less than thirty preparations in exchange. This shows that one can secure a large collection of objects at a very trifling cost, if he will mount some interesting objects and offer them for exchange.

Once more we state that we seldom know anything about the kind of material that is sent out in exchange. One must expect to receive some poor things among the good ones, and the most we can do is to urge our readers to select for exchanges good material and to mount it well.

— We are pleased to notice that the Boston Society of Natural History is again enabled to announce that a sea-side laboratory, under the direction of the Curator, and capable of accommodating a limited number of students, will be open at Annisquam, Mass., from July 1st to September 1st, 1882.

The purpose of this laboratory is to afford opportunities for the study and observation of the development, anatomy, and habits of common types of marine animals, under suitable direction and advice. There will be no attempt to give lectures or any stated courses of instruction. For more definite information, application should be made to the curator, Mr. Alpheus Hyatt. We trust some of our readers will avail themselves of this opportunity to learn how to study the processes of growth and development.

Annisquam is situated on an inlet of Ipswich Bay, on the north side of Cape Ann, and is about three and a half miles, by coach, from the Eastern Railroad Company's station in Gloucester.

CORRESPONDENCE.

SWARM-SPORES OF CLOSTERIUM.

TO THE EDITOR.—On reading the article on the reproduction of *Closterium* by swarm-spores, in the March number of the MICROSCOPICAL JOURNAL, I at once recognized the resemblance between the figure 8 there given, and the figure of *Chytridium endogenum*, described by Alexander Braun as inhabiting *Closterium lunula*. Braun believed that the microgonidia of *Closterium*, described by Focke, were merely the zoöspores of the *Chytridium*. In the paper by Mr. Holland, he states that the round bodies found were green, as well as the swarm-spores themselves. In *Chytridium*, however, there is no green color, but the parasite is nearly colorless. Inasmuch as the resemblance to *C. endogenum*, is in most points surprisingly great, would it not be well to inquire whether there has not been some error in describing the color in the JOURNAL, and also the approximate number and size of the zoöspores, coming from a single cell.

W. G. FARLOW.

CAMBRIDGE, April 21st.

PHOTO-MICROGRAPHS.

TO THE EDITOR.—I have been working for some time past to simplify the technique of photomicrography and, I think, with very good success, as I find that by the use of dry-plates I am able to dispense with the use of a heliostat for powers below 600 diameters.

It will be admitted that this is a great desideratum, as the heliostat is a somewhat expensive piece of apparatus, and requires a certain amount of skill for its management.

It is my intention to give a detailed account of the technique as perfected by myself, in the introduction to a work soon to be published, which will be entitled "Elementary Lessons in Biology," and which will be illustrated by photomicrographs reproduced by the heliotype process.

A communication in the April number of the MICROSCOPICAL JOURNAL has induced me to send you the photomicrographs enclosed with this letter.

In the communication referred to, Prof. Kain announces his success in making photomicrographs by lamp-light. I made some experiments in this direction in Baltimore last summer, and convinced myself that for low-powers it was quite practicable to use a powerful oil-light, as the source of illumination, but the long exposure required, and the indifferent results I obtained caused me to abondon the oil-light in favor of sunlight reflected from a clear sky.

I am quite surprised at the brief time of exposure, which Prof. Kain has found sufficient, and would be very glad to see some of his photomicrographs, especially those made without removing the eye-piece. My experiments were made with Carbutt's extra-rapid plates, and without an eye-piece, but the time of exposure required, was so great that I abandoned the method.

If Prof. Kain, has succeeded in making good photomicrographs, with an oil-light and without removing the eye-piece, in the brief time mentioned, he has certainly done very much to popularize an art which has heretofore presented so many difficulties, and required such elaborate apparatus that considerable time, patience and money were necessarily expended by the few who have been successful in making satisfactory photomicrographs with high powers.

I have for several months past been working without a heliostat, using light reflected from the sky on a bright day. For the highest power mentioned (600 diameters), it is essential that the sky be free from clouds, and the atmosphere not at all hazy. I enclose a photomicrograph of bacteria, made in this way without the use of a heliostat. The time of exposure was twenty-five minutes, and the plate was manufactured by the Eastman Dry-plate Co., of Rochester, N. Y. I have been using these plates exclusively for some time past, and am much pleased with them.

GEO. M. STERNBERG.

May 1st, 1882.

[We are indebted to Dr. Sternberg, for a number of very excellent prints, which are at this office where they can be seen by any person who is sufficiently interested in the subject to call for them. As regards the time of exposure, it is certainly possible to make good negatives with exposures of one and a half to three minutes, using a student's lamp, as Prof. Kain has stated; but it is also possible that more detail would be developed by giving another half a minute—we have thought so from the result of a recent experiment, but have not made another trial to test the matter.—ED.]

MICROSCOPICAL SOCIETIES

A regular meeting of the STATE MICROSCOPICAL SOCIETY OF ILLINOIS was held on Friday evening, April 12th, Dr. Lester Curtis in the chair.

Dr. Elbert Wing read a paper on "The Arterial Terminations, the Malpighian and Oval Splenic Bodies, and the Honey-comb of Membranes, in the Spleen."

The writer gave an account of the honey-comb of membranes described and figured by Klein. This honey-comb is only a plexus of blood-vessels, continuous with the arteries on one side and the veins on the other. From the interior of these vessels there project buds, which appear to grow and become detached and enter the blood-current. These buds, together with the honey-comb membrane, Klein considers to be the substance of the pulp of the spleen. He then described some investigations on the terminations of the arteries of the spleen, conducted by Drs. H. K. and C. G. Jones, which were suggested by some studies on the subject by Dr. Salisbury, of Cleveland, Ohio. According to these researches the arteries of the spleen terminated :—

1st. In tubular glands followed by simple capillaries.

2d. In tubular glands followed by oval-splenic bodies.

3d. In Malpighian bodies (rarely).

4th. In capillaries directly, without the intervention of tubular glandules.

The Malpighian bodies are well-known as occurring in the gaps of the small arteries, sometimes on their sides. These the Drs. Jones consider to be merely the lymphatic glands of the spleen, having no connection with the blood through the lymphatics. The tubular, glandular and oval-splenic bodies are new structures. The first of these are the direct continuation of some of the smaller arteries. When the artery passes into one of these structures its calibre becomes very much narrowed and its walls thickened. It seems to be lined with a glandular Epithelium. They may terminate in capillaries or in the oval-splenic bodies. These last bodies are "the expansion of the fibrous coat of the tubular glandules into an oval head or thin-walled sac." "In other words the oval-splenic body represents the capillary system which connects one arterial with one venous extremity." "The oval-splenic bodies are the active organs of the spleen, and are bodies which have been described as splenic cells, and pulp." The writer spent some time in studying the subject in the spleens of various animals, and in the human spleen. He agrees with Dr. Klein as to the termination of some of the arteries in sinuses into which budding cells project. He also finds the tubular glands and oval-splenic bodies, and thinks they are actual structures, and not false appearances due to faulty preparation. He thinks, however, that the oval bodies are always found at the termination of the tubular glands, and that their absence is due to their being torn or cut off in making the preparation. The most common termination of the arteries, however, is the capillaries. He did not find any artery termination in a Malpighian body. The paper was illustrated with drawings.

Mr. Bulloch described his method of measuring the magnifying power of oculars. The apparatus used by Mr. Bulloch is described elsewhere in this JOURNAL.

At a meeting held April 28th the following officers were elected for the ensuing year: President, Dr. Lester Curtis; Vice-presidents, Prof. E. J. Hill, Prof. E. S. Bastin; Secretary, William Hoskins; Corresponding Secretary, E. B. Stuart; Treasurer, W. H. Summers.

NOTICES OF BOOKS.

Bird's Nesting: A Hand-book of Instruction in Gathering and Preserving the Nests and Eggs of Birds for the Purposes of Study. By Ernest Ingersoll. Salem: George A. Bates, 1882.

This book is published in a manner to attract the reader by its appearance, even if he be quite ignorant of the subject. A number of useful and ingenious devices for assisting the collector of eggs and nests are described. That the writer pursues the science *con amore*, is easily seen. In his "Plea for the Study of Nests" he rises into the psychology of the subject, for he says: "it gives a glimpse of the bird's mind, and furnishes an entrance into the very *soul* of ornithology."

The author describes the best methods for finding, transporting, labelling, and storing eggs and nests, and gives much practical information for the novice in collecting.

Mr. Ingersoll's style is pleasing, and the reader cannot fail to observe that he is an enthusiast in his study. Indeed, one must needs have a heart of stone if he would pursue the study of ornithology and not come to love the feathered songsters whose homes and haunts he penetrates; and when, in pursuing the study, his mind sees beyond the many curious facts regarding the life, habits, and instincts of the birds, it will not seem strange that all who begin the study find in it a fascination, which is enhanced by the delightful accompaniments of fresh, country air and scenery. A list of birds concerning which but little is known is given at the end of this treatise on oölogy, which, with a conceit that may be forgiven in an enthusiast, the author regards as the "foundation of ornithology, and animal life, and biology in general, and finally, the whole of human learning." E. C. H.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

On receipt of a well-mounted slide, I will send a slide of crystal, (for the polarzer) of any of the rare vegetable products which I may have; will send list of same on receipt of postal request.

J. KETCHUM, Jr.,
P. O. Box 877, New York City.

Wanted. — Animal parasites, Ixodes, Acari, etc., either mounted or unmounted. W. A. HYSLOP,
22 Palmerston Place, Edinburg, Scotland.

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Fowl Cholera and the Germ-Theory of Disease.

BY D. E. SALMON, D. V. M.

No longer than a year ago, there were so many criticisms of the germ theory continually appearing in our medical and scientific periodicals that the writer felt it a duty to place the evidence bearing upon the question before the working microscopists of the country in such a connected form that they could scarcely fail to appreciate it. Accordingly the investigations of the best studied of the contagious fevers, viz., charbon were reviewed in two articles published in this JOURNAL of April and May, 1881, and the conclusion reached that there could no longer be a shadow of doubt of this disease being produced by the multiplication within the body, of the *Bacillus anthracis*, a variety of bacteria.

After patiently waiting a year to allow those who oppose the germ theory ample time to place their objections to this evidence on record, without any such objection appearing, it may be concluded that, up to this time at least, there are no substantial grounds for doubts. Still, we occasionally see elaborate articles intended to prove that the bacteria of contagious diseases are nothing more or less than one of the forms assumed by coagulating fibrin—that the micrococcus is granular fibrin, the bacillus, thread-like fibrin and the spirillum spiral fibrin ;* and though it may now be assumed that a majority of our scientific men are convinced of the truth of the germ-theory, the evidence upon which it rests is yet entirely too slight if we except the single disease already alluded to.

As a working theory, we have seen more light thrown upon contagious fevers by its use for half-a-dozen years than was gained before in the whole history of medicine; but notwithstanding this, its true friends do not care to press its acceptance in advance of the actual results obtained by scientific investigations. Charbon, as we have seen, is the foundation of our structure, and we may feel certain that this foundation is secure, and will never crumble beneath the successive additions that may, from time time, be placed upon it. Has the time arrived, therefore, when we may confidently announce that the first story of the edifice has been reared upon the foundation, and that it is so well finished as to be perfectly safe for use, and to serve in turn as a support for future work? The writer believes that this time has come, and will proceed at once to a consideration of the work accomplished.

The domesticated fowls of various countries, including our own, are subject to a most virulent and fatal disease which, year after year, almost depopulates the poultry yards of vast sections, and causes enormous aggregate losses. This disease may be communicated to healthy fowls by placing these in the same enclosure with sick ones; by feeding them with the flesh or blood of recently dead birds; or by introducing portions of the flesh or blood of very sick or

* Rollin R. Gregg, M. D. No Bacteria in Diphtheria.—*The Medical Record*, Feb. 1, 1882

dead birds beneath the skin. The disorder is not accompanied by eruptions on the skin, but is characterized by elevated temperature, dullness and loss of appetite, often deep somnolence, by paleness of the fleshy parts about the head, and by yellow coloration of that part of the excrement which is separated by the kidneys. The most marked and constant lesion is an intense congestion of the liver with enlargement and softening; and there are frequently other complications which, for the purposes of this communication, it will be unnecessary for me to enumerate. My aim is simply to establish the fact that this

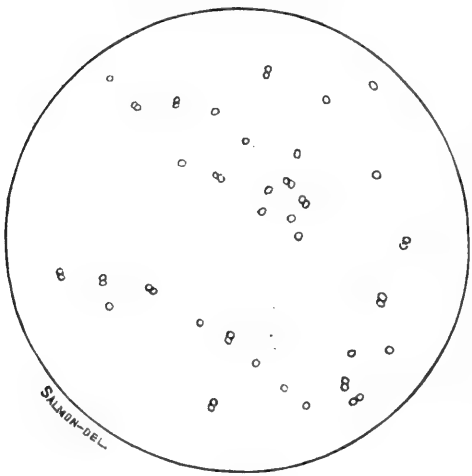

FIG. 34.

FIG. 34.—Micrococci of fowl cholera, from a stained preparation of cultivated virus, X 1000.

is a virulent internal disease, or in other words a contagious fever.

A little over two years ago M. Pasteur presented his communication on this affection to the Academy of Medicine,* and shortly afterwards the writer began his investigations of it which were continued until the present, and are not yet entirely finished. The facts demonstrated by these researches, which bear upon the etiology of the disease, are briefly as follows :—

1. *The virulent liquids of the fowl's body contain micrococci.*—If we examine the blood or tissue-juices of a bird nearly dead of cholera, or from one that has recently died, we may find a considerable number of granules having the dumb-bell form, or some apparently single globules, caused by one part being directly beyond the other in the line of vision. These bodies are extremely small, less than $\frac{1}{30000}$ th of an inch in short diameter, and perfectly motionless. If the microscopist relies upon this examination alone, however, it would not be strange if he remained in doubt as to the nature of the granules which he has discovered. They might very reasonably be considered as granular fibrin, as the debris of broken down cells, or as particles of uncertain nature which have gained entrance from the atmosphere. It will be found difficult in many cases, if not generally, to obtain the bacterial reaction to coloring matter by staining with anilin, violet, or other agents.

Fortunately, the microscopist of today has the means of accurately determining the nature of such granules —this is accomplished by their cultivation in suitable media. Pasteur demonstrated that these granules might be cultivated in a liquid obtained by simmering the muscles of fowls in water and afterwards filtering to transparency and sterilizing by heat; this I have confirmed by long-continued and careful experiments.

Can we be certain, however, that the organisms which we are cultivating, really existed in the blood of the fowl while circulating in the veins, or may they not have gained entrance from the air? This objection is more pertinent than many imagine, for notwithstanding assertions, the probabilities are that very few persons, taking the world over, have made pure cultivations from virulent liquids. Klein believes that he has done this with the virus of the dis-

* L. Pasteur. Sur les maladies virulentes et en particulier sur la maladie appelée vulgairement choléra des poules.—*Bulletin de l'Académie de Médecine, 1880, p. 121.*

ease which he calls *pneumo-enteritis* of swine, and which is so well-known in this country as hog cholera; but my own investigations do not confirm this, for I have always obtained by cultivation an entirely different organism, being the one which Klein himself discovered in the tissues of affected animals, and which he was led to discard by what I am forced to consider most imperfect cultivation experiments. Even Doctors Wood and Formad are constrained to admit that in their cultivation of the supposed virus of diptheria, if the temperature was varied, a different organism frequently appeared.* These gentlemen selected the cultivation-apparatus which misled Klein, and which, to say the least, is hardly suited to investigations of this delicate nature.

The writer has used an apparatus of his own, which will be fully described in his report to the Department of Agriculture of 1881, and which in his hands has given the most complete satisfaction. Instead of using one or two drops of liquid for a cultivation-medium, the usual quantity is half an ounce; and this has been increased for special purposes to a quart. A small fraction of a drop of virulent blood added to such an apparatus, with suitable precautions for excluding atmospheric bacteria, will cause the limpid liquid which it contains to become opalescent, or turbid, within twenty-four hours, and a microscopic examination shows this turbidity to be due to vast numbers of the dumb-bell forms already mentioned. If the blood is obtained and introduced with proper care, it will be in vain for us to search our preparations for other forms of bacteria, and no matter how long we preserve our cultivations, nor at what temperature we keep them, the result will be the same. Having made a pure cultivation of the organism, if our apparatus is perfect, it will remain pure indefinitely.

With a single cultivation and without other tests, we might be uncertain as to whether the bacterium obtained really existed in the blood, or whether it was of atmospheric origin; but when we have repeated the experiment a considerable number of times, always obtaining organisms morphologically the same, and these very different in essential characteristics from the bacteria which multiply in similar liquids after exposure to the air, we are warranted in concluding that they were not introduced from the air but from the blood.

Now, when we have proved that a certain bacterium exists during life in the blood of affected birds, is that good evidence that the disease is caused by such organisms? Evidently, it is very insufficient, but fortunately we are able to satisfy the most fastidious on this point, by additional facts.

2. *Liquids in which bacteria are cultivated produce the disease by inoculation.*—If we add one-fourth of a drop of virulent blood to five hundred drops of cultivation-liquid, and place this in an incubator at 90° F. for twenty-four hours, or until the development of micrococci has produced turbidity, we find that inoculation with this liquid as surely produces the disease, and that this is as fatal, as when virulent blood is the material used. But there is a point here that is nearly always overlooked by those who make this class of investigations: perhaps this cultivation, as we call it, is only a dilution of the original virus—a dilution not sufficient to destroy its activity. We have used a half-ounce or more of liquid, and have made a dilution of 1 to 2000—a dilution much greater, it is true, than is usually made by those who cultivate in but a drop or two of fluid in a small cell—but it is our object to give a scientific demonstration and not to follow in the uncertain footsteps of those who have preceded

* Drs. H. C. Wood and H. F. Formad. Report on Diphtheria.—*Supplement No 17, National Board of Health Bulletin, p. 6.*

us. To test the extent to which the virus may be diluted, we inoculate healthy fowls with a drop of various dilutions of our cultivation-liquid, obtained as above, and which may be called the first generation, and we find that a dilution of 1 to 2000 almost invariably produces death. The virulence of a first cultivation then proves nothing, and we must stop to inquire the extent to which such virulent liquids may be diluted and still prove fatal when there is no opportunity for reproduction. Experiments show that death is frequently produced by dilutions of fowl cholera virus of 10,000 but rarely by those of 1 to 20,000 or 1 to 40,000, and seldom, if ever, by greater dilutions.

We are now in a position to judge if the virus really multiplies as we know the bacteria do. We have found the extent to which the first generation must be diluted to destroy its virulence and we make a second cultivation which dilutes the first as the first dilutes the blood; after twenty-four hours, we start a third cultivation, and now the first is diluted in the proportion of 1 to 4,000,000, or far beyond the extent to which it was found possible to dilute it without destroying its properties when no cultivation was allowed. Have we in this case destroyed the virulence? No, indeed; a single drop of the third, fourth, fifth or sixth cultivation will destroy ten thousand fowls as surely as a drop of the first. The virus has been cultivated then, has multiplied, and is capable of indefinite multiplication. Our liquid swarms with micrococci and nothing else can be found by the most careful microscopic examination. If we expose virulent liquids to atmospheric germs, putrefaction soon occurs and their activity is lost. Why has not the same result followed in our cultivation liquids if the bacteria multiplying in them were foreign to the virus? Have we not, even here, a strong indication that these organisms are the active principle of the virus—that they produce the disease?

3. *The living bacteria are required to produce the malady.* — There are three hypotheses which one must take into account in determining the active principle of even this cultivated virus. 1. The pathogenic agent may be a soluble ferment. 2. It may be living particles (bioplasm) extremely minute, or having the same refractive index as the liquid in which it multiplies, and therefore invisible. 3. It may be the bacteria to which our attention has already been directed. Pasteur has shown that by filtering the cultivated virus through plaster, the solid particles are removed and the limped liquid which is obtained is perfectly harmless, even when injected under the skin of susceptible birds in considerable quantities. Objection being made to the filtering as liable to remove some dissolved bodies as well as the solid particles, the same able investigator has given us another and very valuable demonstration. If tubes containing cultivated virus are placed where the temperature is constant, the micrococci are all deposited on the bottom of the apparatus, leaving a perfectly limped liquid above them. Inoculations with this liquid prove it to be as harmless as that which has been filtered.*

Even this demonstration was insufficient to convince those who oppose the germ-theory—the ferment might be very volatile and escape from the upper layers of the cultivation-liquid, or it is attached to the bacteria themselves and can only be introduced with them. To meet such objections the writer has carried through an entirely different line of investigation. It was found after considerable experimenting, that the activity of the virus is destroyed at a temperature of 132° F. if maintained for fifteen minutes—a temperature so low that few, if any, chemical bodies would be affected by it if protected from atmospheric gases and evaporation. Small glass tubes were, therefore, completely filled

* *Bulletin de l'Académie de Médecine*, 1880, p. 530.

with virus, hermetically sealed, and placed for a quarter of an hour in water of this temperature. Here there was no chance for any constituent to escape, and the dead organisms might be introduced into the inoculation-punctures with whatever chemical products there might be adhering to them. Now, what is the result of inoculations with virus treated in this way? Experiment shows that a million times as much as produced death before, is now unable to cause the least sign of disease. The liquid is no longer capable of producing the affection.

Still, our opponents may maintain the demonstration more or less imperfect—the activity of the virus is destroyed at this low temperature, it is true, but what evidence have we that the bacteria were destroyed rather than the other agents which we have supposed might constitute the active principle. Some bacteria resist a boiling temperature for a longer time than this; others multiply rapidly and seem to enjoy a temperature nearly thirty degrees above that to which we have subjected our virus. Is it not impossible that the micrococci under consideration were killed at so low a point?

The fact that this virus is destroyed so easily, and that bacteria often resist such high degrees of heat, certainly makes our evidence so much the stronger if we can prove that the micrococcci which we have cultivated are actually destroyed at this point; for it would be extremely improbable that an accidentally introduced organism would be destroyed at exactly the same temperature as some unknown agent which was present, and upon which the activity of the liquid depended.

Let us take two sets of cultivation-apparatus containing sterilized liquids of the proper kind, and to each of these add, with suitable precautions, a minute quantity of a pure cultivation of the micrococci. The one we heat for fifteen minutes to 131° F., the other to 132°, and place both in the incubator to await developments. In twenty-four hours the former is turbid with micrococci, but the latter is as limpid as at first; we wait for two or three days but there is no change in our results. We now inoculate a number of fowls from each apparatus, and find that in those cases where the liquid containing the micrococci is used the birds contract the disease while those inoculated with the clear liquid are not affected in the least.

Our demonstration is now complete—we have started with the micrococcus and tested each hypothesis without other result than to show that they are both untenable, and after traversing the whole circle of investigation we are led back to this organism as the pathogenic agent without which in a living condition, there is no virulence.

We believe, therefore, that the second step in the germ-theory is taken, the second story of the structure finished; and we place the results before the scientific world with the fullest confidence that they will be confirmed and accepted.

It will be noticed that many of the investigations appear on their face to be rather of a chemical or pathological nature than microscopical, and as such would be out of place in this JOURNAL. I beg leave to remind the reader, however, that no one but a microscopist can succeed in such researches—the microscope is necessary at every step, and it has been a part of my purpose to show that the microscopist who undertakes to solve these difficult questions, must be prepared to use other apparatus in connection with his instrument.*

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The Micro-organisms of Tubercular Disease.

BY DR. L. SCHÖNEY.

In response to your request, I will endeavor to bring before you this

* My investigations have been published in the Reports of the Department of Agriculture.

evening* a brief *résumé* of the discovery, by Dr. Koch, of the micro-organisms to which tubercular diseases are due. I will go only so far as may interest scientific microscopists, discarding all views from a medical stand-point. For this discovery, though at first it seems to be purely of medical interest, is certainly within the realm of the biologist and the field of the microscopist. As long as the origin and the stages of development of bacteria have not been clearly recognized, the practical physician does not know when and where and how these enemies of life are to be found or attacked. It is true, in surgical operations much has been accomplished, since it has become an acknowledged fact that decay in wounds —suppuration and pyæmia—are due to such bacteria. Operations not dreamt of before—such as the cutting out of part of a diseased stomach, œsophagus, or pylorus, of a whole kidney, a larynx, a spleen—are undertaken with the chances in favor of success, because we can fight these organisms by sight, as it were.

We can chase the germs away from the feasts we have provided, that is to say, from open wounds, by antiseptics and disinfectants, and by excluding the air, their vehicle. But those internal diseases which cannot be reached by the knife or by caustics, such as diphtheria, scarlet-fever, measles, typhus, and, most of all, tuberculosis, commonly known as "consumption," which alone kills constantly one-seventh of the human race, remain as much a puzzle to the physician as a curse to humanity.

Some of these micro-organisms are harmless, others obnoxious; we are at their mercy small as they are, great as we think ourselves to be; they pollute our air, our food, our drink; they surround us like a host of enemies—neither fire nor sword, neither electro-cautery nor the surgical knife will destroy them. But the discovery which I have the honor to lay before you this evening, and which was effected only by means of the microscope, leads us to hope that we may yet reach them in their original habitat.

Dr. Rudolph Koch, while practising in the small village of Wollsten, devoted himself for many years to the study of bacteria, and four years ago published his celebrated *critique* on Nägeli's work "The Lower Fungi, in their Relation to Infectious Diseases." He made experiments in the cultivation of *Bacillus anthracis* (the bacterium of splenic fever), after Pasteur, and succeeding in this, he made Villemin's experiments with tuberculous matter in lower animals. Villemin, ten years ago, pronounced tubercle to be a specific disease, capable of infecting others, and due to a specific virus; but neither Villemin nor Cohnheim, our greatest histological microscopists, both of whom hunted for the specific bacterium was successful in the search.

So recently as the beginning of this year, Cohnheim, in one of his last lectures on pathology, said "The direct proof of tuberculous virus is to this day yet an unsolved problem." Cohnheim and Klebs took tuberculous matter in all stages, examined it by different methods, prepared it with different stainings; they found bacteria such as had been found in other diseases, but they did not attain the object of their search—a specific tubercular bacterium. It was reserved for the brilliancy and accuracy of the method of Koch, in his microscopical investigations, to bring to light this entity, this poisonous virus, which he recognizes as the true cause of those wasting diseases known as tuberculosis. I must state here that Koch includes by the term tuberculosis, both scrofulous and catarrhal phthisis, and tuberculous disease of the brain, the intestines, and other organs.

The novel feature of his investigation consists first: In the method of staining, combined with the proper

*Read before the New York Microscopical Society, June 2d, 1882.

illumination; second, in the application of a new method of bacterial cultivation, viz., with a solid, transparent matrix of nutrition.

On the 24th of March, 1882, Dr. Koch laid before the Physiological Society of Berlin, the result of his incessant labor and study. His method was substantially the following:—

He took tuberculous matter in the liquid state, spread it in a thin coating on the cover-glass, dried it, then heated it carefully so as to render it insoluble. He placed this in an alcoholic solution of methyl, which was prepared by dissolving one c. c. of concentrated alcoholic solution of methyl-blue in 200 c. c. of distilled water, to which 0.2 c. c. of a 10 per cent. solution of caustic soda had been added. After 24 hours soaking of the tuberculous matter in this solution, or less if the solution is kept at 104° F., the specimen was colored blue by the methyl. It was then well-washed with a very dilute solution of vesuvin. The vesuvin has the peculiarity of neutralizing the blue coloring of methyl in all the tissues, turning them brown, but leaving the bacilli unchanged.

The specimen is now to be treated with absolute alcohol, then put up in oil of cinnamon, and finally prepared with Canada balsam. As seen under the microscope by Koch, using Abbe's condenser without diaphragm and the strongest Zeiss oil-immersion lens, the tuberculous bacilli appear distinctly differentiated as blue, rod-shaped bodies, one-fourth of the length of a red blood-corpuscle, *i. e.* being about $\frac{1}{1500}$ of an inch long, their width $\frac{1}{4}$ of this, slightly cleft at one of their ends. They resemble *Bacillus leprœ*, which also resists the staining of vesuvin, but are thinner, and are not split at one end. All the other bacilli that Koch experimented upon, staining them blue with methyl, were washed out by vesuvin. We possess, therefore, in vesuvin, a chemical reagent as it were, for the tubercular bacilli. Now, to establish the fact that these bacilli are the essential cause of the disease and not *post hoc* accident, Koch endeavored to isolate these bacilli, and to inoculate with them healthy animals.

He employed a method that originated with Tyndall, employing a so-called sterilized fluid; a special cultivating substance was prepared out of the serum of ox-blood, which he first heated several times up to 48° C. in order to destroy all organisms; then he heated it again to 75° C. until it was reduced to the consistency of a brownish-yellow, transparent jelly. This condition of the substance enables usto recognize the slightest turbidity that begins to form therein. In this matrix, prepared in a test-tube, was introduced a small particle of tuberculous matter from a freshly killed and infected animal, which became diseased by artificial inoculation.

Within ten days the bacilli gave off several spores, which developed into rod-bacilli similar to those brought out by the double-staining described above. With those seeds a new matrix was fertilized, and this process was kept up by Dr. Koch for 200 days, always producing the same bacilli.

Those animals inoculated with the early or later generations, with the pure, grayish-white specks which appear as the propergerms in the matrix, became rapidly diseased and died—more rapidly than those inoculated with the tuberculous matter of the animal; even those animals that possess a comparatively greater immunity from tuberculosis became diseased to an extent involving all their organs, when inoculated with those cultivated bacilli. They were injected by slight wounds in the veins, eye and abdomen. The development, however, goes on very slowly, but it has its definite periods and its limitation. The culture-fluid injected without the bacilli never produced tubercles.

Koch found that they grow only at a temperature between 30° and 41° C.

in this respect differing from anthrax bacilli, and Koch infers from that that tuberculosis cannot arise from the air, or from the water, or from plants, but from animals, because the tuberculous bacilli can only live at the temperature of animal life.

By these experiments, laboriously carried out with untiring patience, it is proved in the most exact manner that the bacilli brought to light first by Koch, by the method of double-staining of the tissues, are actually the true pathogenic organisms of tuberculosis.

I may be allowed here to digress with a brief remark upon the importance of staining, which, by some microscopists has hitherto been underrated. Even a noted teacher of histology recently took occasion to ridicule this show of staining, which he designates as an æsthetic luxury, only good for public exhibition to laymen, which, however, masks more than represents the true nature of tissues. Yet the use of staining fluids is as important to the scientific microscopist, and especially to the histologist, as the spectroscope is to the chemist. It enlarges his field, and brings out to view distinctions, and differentiates individuals of germs of a distinct protoplasmic nature and energy akin to a certain reagent and not to another, as the discovery of Koch clearly shows.

The great importance of the investigation of the etiology of infectious diseases is apparent to everybody; to the practitioner it opens the view, though in the distant perspective, of a possibility that a disease which, for thousands of years has more than decimated the human race, can be caught and perhaps fought, literally in its germs.

Prof. Tyndall, in speaking of Dr. Koch's discovery, in his enthusiasm goes so far as to hint the suggestion that these bacilli could probably be modified by cultivation to a state in which they become prophylactic—as vaccination in small-pox. Indeed, he regards Koch's discovery as one of the greatest events in science. I myself think the truth or fallacy of this theory cannot be settled yet, and that it requires further extended experiments, especially on man himself—perhaps on criminals, if their terms be extended. For there are many questions to be raised against the contagiousness of tuberculosis; for instance why students who dissect many such cadavers are not more frequently infected by the poison, and why widows or widowers of a husband or wife dead of consumption, do not as a rule, follow them soon, out of tubercular sympathy. These questions are not cleared up yet, much less answered, nor are the postulates of the epidemiological experience done away with; but so much is certain, that these admirable experiments show the path by which the certainty of decision can be reached. It is the duty of the microscopists, the detectives in the corps of scientists, to bring to light these invisible enemies to human life, to espy and to find them; and the duty of the physician to defy and fight them.

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Abstract of the Address of the President of the Royal Microscopical Society, London.

(*Continued.*)

Mounting-media of High Refractive Indices.—To utilize the full benefit of immersion objectives, it is of course essential that the object should be mounted in a medium, the refractive index of which is not less than that of the immersion fluid; and down to a comparatively recent period Canada balsam was most commonly used for this purpose, particularly for diatoms.

Mr. Stephenson, however, pointed out that although by the use of the balsam we have attained our object

so far as the aperture is concerned, yet we have done so at the expense of the visibility of the resultant image, which has become fainter by the nearer approximation to equality of the refractive indices of the diatomaceous silex and the balsam; the visibility of minute structures being proportional to the difference between the refractive indices of the object and the medium in which it is mounted.

* * * * * * *

Continuing his researches on this subject, and endeavoring to find the best media with high refractive indices, he has quite lately brought before the Society the utility of an aqueous fluid capable of being given the high refractive index of 1.68, viz., a solution of biniodide of mercury and iodide of potassium in distilled water. This more manageable and highly antiseptic medium appears likely to turn out to be of great use in the observation of many objects, as it can be diluted till the index of water is obtained. This is of advantage with such objects as muscular fibre, which are themselves of high refractive power, so that fluids of low refractive power must be made use of to obtain the required difference for more perfect visibility. The same communication also contains what was much wanted, detailed practical directions for mounting.

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In addition to the increase in visibility, there is also the fact that by means of such mounting fluids, the capacity of stereoscopic binoculars with the higher powers is considerably enhanced. True stereoscopic effect, as we have seen, requires a depth of vision not less than the thickness of the object under observation—a depth which, as already shown, increases in direct proportion with the increase in the refractive index (n) of the mounting fluid. If one object is in the air when $n = 1.0$, whilst another is in a solution of phosphorus, where $n = 2.1$, the depth of vision will be more than doubled. Objects, therefore, that by reason of their thickness could only afford an unsatisfactory stereoscopic effect in air, may be seen in full relief when mounted in phosphorus.

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Relative Value of Objectives with Large and Small Apertures ("All-round Vision").—I now come to a much-vexed question, that of the relative value, practically, of objectives of large and small apertures, in regard to which a great variety of opinions have been promulgated.

The oldest of these views was that which made the preference between the two kinds of objectives depend upon whether they were to be used for the "ordinary purposes of the biologist," or for the examination of diatoms or other lined objects. The objection to this view is, that it assumes the only function of a large aperture to be its resolving power, a much too restricted notion, and one which deprives the working biologist of a most essential aid to his observations upon structures.

A more modern view errs in the opposite direction, and insists upon the universal superiority of large apertures, so that work done with small apertures will "have to be done over again."

There is again a third view, still more recently put forward, which goes much further than the preceding, and according to which it is impossible that wide apertures can give correct images. First on account of the unnatural "all-round vision" which it is contended is obtained with them, and secondly by reason of their supposed inherent defect in defining power, in consequence of the dissimilar images presented by the different parts of the enlarged area of the objective, with a confused image as the general resultant.

The want of exactness in the first two suggestions will sufficiently appear, when we have formulated the grounds upon which large apertures

are shown to be indispensable for all observations upon minute structure for which high powers are necessary; but it will be desirable first to point out the erroneous interpretations upon which the third view (as to all-round vision and dissimilar images) has been founded, and for this purpose it will be necessary to refer to the paper by Dr. Royston-Pigott, F.R.S., in which the subject is dealt with.*

* * * * * * *

Now, it is necessary to say plainly, this view is founded upon a fundamental error, "belonging," to use Professor Abbe's words, "to the venerable relics of the past *naïve* period of microscopical science, which was characterized by an unshaken conviction in the validity of the hypothesis that microscopical vision is in all essential respects the same thing as ordinary vision." The "all-round vision," by virtue of which we are supposed, when looking at a minute cube, to see at the same time the top and all the sides (with the result of rounding off the corners and angles!), does not really exist, as can be shown by the application of the simplest laws of geometrical image formation. The different obliquities of the rays in an objective of wide aperture cannot give rise to any all-round vision, for in the microscope there is no difference of perspective attendant upon oblique vision as with the naked eye. The difference of projection of successive layers which exists is ineffective, except in the case of binocular vision. This absence of perspective may be readily established by examining an object alternately by an axial and an oblique ray; it will be found that there is no shortening of the lines in the latter case, and no capacity in the microscope, therefore, for "all-round vision." Indeed if this theory were correct, microscopical vision, even of plane objects and with very moderate apertures, would be entirely destroyed.

Equally mistaken is the second branch of the view which I am considering, viz., that a wide aperture must, in the nature of things, impair definition on account of the increase thereby produced, in the dissimilar images received through the several parts of the objective. In support of this view, illustrations drawn from stereoscopic vision are adduced, which admittedly does depend upon the dissimilar images formed by the right and left-hand halves of the objective; but, as Professor Abbe has shown, the dissimilarity of images presented by an objective of wide aperture is a dissimilarity in the projection of successive layers only, and this is not effective unless we produce these images by different portions of the aperture separately and conduct them to different eyes, as in binocular microscopes. The sole effect of the wider aperture, when the images are not so separated, is a reduction in the depth of vision—to confine us to the vision of thinner objects, not to impair the definition of what is seen when the objects are within the range of penetration.

If we pass to practical experience, we shall find that the principles which theory establishes are amply confirmed. All who have worked with wide-angled objectives cannot fail to have recognized the great fact of modern practical optics, the perfection of definition obtained with such glasses—a fact which has been verified by such authorities as Mr. Dallinger, who, so long ago as 1878, stated of a new ⅛-inch homogeneous-immersion objective of the wide aperture of 1.25 that "the sharpness and brilliancy of the definition which this lens yields is absolutely unsurpassed in my experience."

The question of the power of resolution supposed to be possessed by small apertures can also be brought to a very simple practical test by those who believe in that view exhib-

* Proc. Roy. Soc. xxxi (1881) pp. 260–78.

iting here to the appreciative assemblage which they would have around them, say 75,000 lines to an inch resolved with the low apertures referred to!

We have seen that on the one hand the depth of vision decreases as the aperture is increased, and that on the other, as the objects become smaller and smaller the similarity of their images increases with the increase in the aperture—the one representing a disadvantage attendant upon large aperture and the other an advantage —and bearing this in mind we are in a position to arrive at a correct view of the relative value of objectives with large and small apertures, which I take to be this :—

Both kinds of objectives are necessary for investigations into the structure of minute objects, and an observer to be fully equipped, should provide himself with two objectives, one of moderate and one of wide aperture. The former would be used for the more general survey of the various parts of the object, and the latter for the subsequent examination of its minute structure. In searching, for instance, through a stratum of fluid for Bacteria, a wide aperture would be unnecessary, but when a particular Bacterium is found, it is only that which will give us an accurate view of its flagellum.

But again, in the choice of the objectives, the proper relation between magnifying power and aperture must be maintained. For work with low powers, it is useless to have large apertures. The structure of the objects for which such powers would be used is not sufficiently minute to require large apertures for their proper delineation, and we therefore expose ourselves to the disadvantage of very restricted penetration and the trouble of delicate manipulation, without any corresponding benefit.

On the other hand, it is equally useless to work with high powers (that is upon minute objects) with small apertures. We should have only an empty amplification—mere increase in the distance apart of the outlines, without any additional structure being made visible in consequence of the defect in aperture.

Whenever the subjects of our examination are so minute as to require high amplifications in order to be seen, then we must also have large apertures in order to obtain perfect delineation of the objects.

Leaving now the theoretical questions, which, after all have so imporant a bearing on our practical work, reference need only be made to the descriptions published in our Journal of new inventions in regard to mechanical and optical appliances (most of which have been exhibited at our meetings) to prove that great progress is being made in the designing, manufacture, and application of the microscope. Improved stands and eye-pieces, new immersion lenses, stages, and swinging substages, more effective fine movements and elaborate accessory apparatus of all kinds, indicate not only the activity of mind and the abundance of the resources of the microscopical optician, but that these things are really required in a progressive science.

It is to be hoped that the possession of excellent instruments and convenient apparatus will incite many of the Fellows to undertake more careful researches into the minute details of organic nature, or amongst the very fascinating rocks which are being so beautifully cut and mounted by petrologists. It is true that the difficulty of getting upon a path of original research is very deterrent. The activity of Continental and American microscopists is indeed great, and it is always necessary, before committing one's self to any statement, to search and prove its originality. Much microscopical research is quite beyond the powers of the man who has other avocations, and to whom the instrument is a pleasing, and none the less important, toy. Consider the paraphernalia required

to study the microscopy of the details of a minute animal. It has to be put into hardening and water-absorbing solutions, then to be cut with microtomes, perhaps frozen in the first instance, then to be put into other solutions to be cleared and to have its fat got rid of, and then it has to be colored once, twice, or thrice, and possibly to have some color discharged. Finally it has to be mounted in a medium. It is necessarily somewhat deterrent for a modest microscopist to read the excessively pronounced opinions of manipulators about the nature of the structure they discover in such complicated and altered organic matter, and to find that very contradictory opinions are published by different investigators about the nature of identical structures which have been differently prepared. It appears to many an amateur, who happens to investigate structures by disturbing their natural condition as little as possible, that he is, as it were, out of the field. He may find it necessary, even in examining the simplest section, to pay especial care to the illumination and centering, and to the application of particular powers. He is, of course, conscious of inferiority, when he knows that somebody merely puts a chemically treated specimen under an objective without the least care about optics, and finds out, or thinks he finds out, the truth. But there are numerous opportunities for original research still to be met with in the structure of many of the commonest invertebrates and plants. The study of rocks is in its infancy, and there are many very interesting physical questions yet to be determined, and which can only be settled microscopically. Recondite manipulation is not much required in any of these researches, but rather a good knowledge of how to use the microscope as an instrument.

If in any case there are obstacles to original research, it is always interesting to follow the work of some distinguished investigator. It is very rarely that a subject is treated exhaustively, and the sedulous yet candid critic, may solve truths which his predecessor had not approached.

In concluding this address, I cannot avoid a special mention of the recent death of a man whose genius and careful microscopical work, established an era in histology, and influenced that study of embryology which must ever be the starting-point of philosophical zoölogy and botany. Theodore Schwann elaborated the "cell theory" forty-three years ago, and in the main it holds good at the present day. He lived to see its value appreciated by every zoölogist, and to be able to follow the researches with improved lenses, and recognize the entities which have no cell-wall. Schwann investigated most successfully the nervous system, and his name will ever remain associated with it. He died at a ripe old age, having led an industrious, simple, and most useful life, and having lived to see himself the recipient, on the occasion of his jubilee, of distinguished honors on the part of the scientific world.

EDITORIAL.

Subscriptions.—Remittances for subscriptions should be made by post-office, or express, money-order, by drafts payable in New York, or in registered letters. Money sent in any other way will be at the sender's risk. A receipt will be immediately given for money received by open mail.

The JOURNAL is issued on the 15th day of each month. Subscribers who do not receive their copies at the usual time are requested to inform the Publisher of the fact.

BULLETIN OF THE MUSEUM OF COMPARATIVE ZOÖLOGY. — In our March number, we noticed the first five parts of the ninth volume of this valuable publication, and now the sixth, seventh and eight parts are before us. It is proposed to issue, in the "Memoirs" of the Museum, a "selection from embryological monographs," which will give to the student a more or less complete iconography of the embryology of each important group of the animal king-

dom, with illustrative plates to be issued in parts. To accompany the plates will be carefully prepared explanations, and a bibliography. The bibliography of the crustacea, by Walter Faxon, covers 53 pages in the *Bulletin* number 6.

Numbers 7 and 8 are in one volume, the first treating of "Explorations of the Surface-fanna of the Gulf Stream," by A. Agassiz, the second "On the Acalephæ of the East Coast of New England," by J. W. Fewkes. Both contributions are accompanied by plates of great value.

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PLANT-CELLS IN ANIMALS.—Two short notices in the *American Journal of Science*, of April, one relative to the "yellow cells" of radiolarians and cœlenterates, the other on the commensal life of animals and algæ, are worthy of attention. The so-called yellow cells occur in most radiolarians; they have a well-defined nucleus and multiply rapidly by division. Similar cells have also been found in other animals, as anemones, jelly-fishes and others. Cienkowski, followed by later observers, regarded the yellow cells as parasitic algæ, and it was observed that those animals which contained the yellow cells, gave out oxygen in sunlight. Mr. Patrick Geddes believes that the cells are chlorophyllous algæ-cells, and that when they die they afford material for digestion by the animal, but living they remove carbonic acid and waste products, and supply oxygen to the surrounding animal protoplasm, "foreign chlorophyll thus performing the respiratory function of hæmoglobin." Four species of this commensal alga are distinguished by Mr. Geddes, who has adopted for it the generic name *Philozoon*.

In the same place we find a notice of some observations by K. Brandt, on the "Commensal-life of Animals and Plants," the results of his investigations on the colored bodies in *Hydra*, *Spongilla*, a fresh-water *Planaria*, and several infusoria. Under considerable magnification, each of the green bodies consists of colorless protoplasm with a nucleus and a bowl-shaped mass of chlorophyll imbedded in it. These chlorophyll-masses he regards as algæ—those occurring in *Hydra*, he names *Zoochlorella conductrix*, and the species from *Spongilla* he designates as *Z. parasitica*.

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STUDIES IN MICROSCOPICAL SCIENCE.—Mr. Arthur C. Cole, F. R. M. S., has begun the publication in London, of a weekly pamphlet entitled "Studies in Microscopical Science," which bids fair to be of great value. The plan is quite a new one, and we can do no better than to quote from the announcement, first stating that the two numbers now at hand fully bear out the Editor's promise, and one of the double-stained sections which we have received is excellent. The announcement reads thus:—

It is proposed by means of a carefully prepared and typical object for the microscope, together with a drawing and descriptive essay, to supply Students, Microscopists, and Members of the Medical Profession, with a ready means for studying. 1. Microscopical Biology. 2. The Physiological and Pathological Histology of the Body. 3. The essentially modern sciences of Microscopical Palæontology, Mineralogy and Petrology. Subscribers will be entitled to the following considerations: Each subscriber will receive every week during the term of his subscription, 1. A microscopical preparation of the highest class and most perfect finish. 2. A printed description of the preparation, in which will be noted: *a*, the literature concerning it; *b*, the habitat, etc.; *c*, the methods employed in its preparation as a means of study; *d*, its principal features, and any necessary additional remarks. 3. A lithograped or engraved drawing, or diagram of the preparation. The preparations during the first year will consist of a series of 26 Histological, 18 Botanical and 8 Petrological sections, issued alternately.

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NUMERICAL-APERTURE TABLE.*

The "APERTURE" of an optical instrument indicates its greater or less capacity for receiving rays from the object and transmitting them to the image, and the aperture of a microscope objective is therefore determined by the ratio between its focal length and the diameter of the emergent pencil at the plane of its emergence—that is, the utilized diameter of a single-lens objective or of the back lens of a compound objective.

This ratio is expressed for all media, in all cases by $n \sin. u$, n being the refractive index of the medium, and u the semi-angle of aperture. The value of $n \sin. u$ for any particular case is the numerical aperture of the objective.

Numerical Aperture. ($n \sin. u = a.$)	Angle of Aperture ($= 2u$). *Dry* Objectives. ($n = 1.$)	*Water-Immersion* Objectives. ($n = 1.33$)	*Homogeneous Immersion* Objectives. ($n = 1.52.$)	Illuminating Power. ($a^2.$)	Theoretical Resolving Power in Lines to an Inch. ($\frac{1}{\lambda} = 0.5269/\mu$ = line E.)	Penetrating Power. ($\frac{1}{a}$)
	° ′	° ′	° ′			
1·52	....	....	180 0	2·310	146,528	·658
1·50	....	....	161 23	2·250	144,600	·667
1·48	....	....	153 39	2·190	142,672	·676
1·46	....	....	147 42	2·132	140,744	·685
1·44	....	....	142 40	2·074	138,816	·694
1·42	....	....	138 12	2·016	136,888	·704
1·40	....	....	134 10	1·960	134,960	·714
1·38	....	....	1·0 26	1·904	133,032	·725
1·36	....	...	126 57	1·850	131,104	·735
1·34	....	....	123 40	1·796	129,176	·746
1·33	....	180 0	122 6	1·770	128,212	·753
1·32	....	165 56	120 33	1·742	127,248	·758
1·30	....	155 38	117 34	1·690	125,320	·769
1·28	....	148 28	114 44	1·638	123,392	·781
1·26	....	142 39	111 59	1·588	121,464	·794
1·24	....	137 36	109 20	1·538	119,536	·806
1·22	....	133 4	106 45	1·488	117,608	·820
1·20	....	128 55	104 15	1·440	115,680	·833
1·18	....	125 3	101 50	1.392	113,752	·847
1·16	....	121 26	99 29	1·346	111,824	·862
1·14	....	118 00	97 11	1·300	109,896	·877
1·12	....	114 44	94 56	1·254	107,968	·893
1·10	...	111 36	92 43	1·210	106,040	·909
1·08	....	108 36	90 33	1·166	104,112	·926
1·06	...	105 42	88 26	1·124	102,184	·943
1·04	....	102 53	86 21	1·082	100,256	·962
1·02	....	100 10	84 18	1·040	98,328	·980
1·00	180 0	97 31	82 17	1·000	96,400	1·000
0·98	157 2	94 56	80 17	·960	94,472	1·020
0·96	147 29	92 24	78 20	·922	92,544	1·042
0·94	140 6	89 56	76 24	·884	90,616	1·064
0·92	133 51	87 32	74 30	·846	88,688	1·087
0·90	128 19	85 10	72 36	·810	86,760	1·111
0·88	123 17	82 51	70 44	·774	84,832	1.136
0·86	118 38	80 34	68 54	·740	82,904	1·163
0·84	114 17	78 20	67 6	·706	80,976	1·190
0·82	110 10	76 8	65 18	·672	79,048	1·220
0·80	106 16	73 58	63 31	·640	77,120	1·250
0·78	102 31	71 49	61 45	·608	75,192	1·282
0·76	98 56	69 42	60 0	·578	73,264	1·316
0·74	95 28	67 36	58 16	·548	71,336	1·351
0·72	92 6	65 32	56 32	·518	69,408	1·389
0·70	88 51	63 31	54 50	·490	67,480	1·429
0·68	85 41	61 30	53 9	·462	65,552	1·471
0·66	82 36	59 30	51 28	·436	63,624	1·515
0·64	79 35	57 31	49 48	·410	61,696	1·562
0·62	76 38	55 34	48 9	·384	59,768	1·613
0·60	73 44	53 38	46 30	·360	57,840	1·667
0·58	70 54	51 42	44 51	·336	55,912	1·724
0·56	68 6	49 48	43 14	·314	53,984	1·786
0·54	65 22	47 54	41 37	·292	52,056	1·852
0·52	62 40	46 2	40 0	·270	50,128	1·923
0·50	60 0	44 10	38 24	·250	48,200	2·000

EXAMPLE.—The apertures of four objectives, two of which are dry, one water-immersion, and one oil-immersion, would be compared on the angular aperture view as follows:

106° (air), 157° (air), 142° (water), 130° (oil).

Their actual apertures are, however, as ·80 ·98 1·26 1·38

or as their numerical apertures.

* From *Journal of the Royal Microscopical Society*.

MICROMETRIC TABLE.

1 μ = one thousandth of a millimetre.

ins.	μ
$\frac{1}{25000}$	1·015991
$\frac{1}{20000}$	1·269989
$\frac{1}{15000}$	1·693318
$\frac{1}{10000}$	2·539977
$\frac{1}{9000}$	2·822197
$\frac{1}{8000}$	3·174971
$\frac{1}{7000}$	3·628539
$\frac{1}{6000}$	4·233295
$\frac{1}{5000}$	5·079954
$\frac{1}{4000}$	6·349943
$\frac{1}{3000}$	8·466591
$\frac{1}{2000}$	12·699886
$\frac{1}{1000}$	25·399772
	mm.
$\frac{1}{900}$	·028222
$\frac{1}{800}$	·031750
$\frac{1}{700}$	·036285
$\frac{1}{600}$	·042333
$\frac{1}{500}$	·050800
$\frac{1}{450}$	·056444
$\frac{1}{400}$	·063499
$\frac{1}{350}$	·072571
$\frac{1}{300}$	·084666
$\frac{1}{250}$	·101599
$\frac{1}{200}$	·126999
$\frac{1}{150}$	·169332
$\frac{1}{100}$	·253998
$\frac{1}{50}$	·507995
$\frac{1}{25}$	1·015991
$\frac{1}{20}$	1·269989
$\frac{1}{16}$	1·587486
$\frac{1}{15}$	1·693318
$\frac{1}{12}$	2·116648
$\frac{1}{10}$	2·539977
$\frac{1}{8}$	3·174971
$\frac{1}{6}$	4·233295
$\frac{3}{10}$	4·762457
$\frac{1}{5}$	5·079954
$\frac{1}{4}$	6·349943
$\frac{5}{16}$	7·937429
$\frac{3}{8}$	9·524914
$\frac{7}{16}$	11·112400
$\frac{1}{2}$	12·699886
$\frac{9}{16}$	14·287372
$\frac{5}{8}$	15·874857
$\frac{11}{16}$	17·462343
$\frac{3}{4}$	19·049829
$\frac{13}{16}$	20·637315
$\frac{7}{8}$	22·224800
$\frac{15}{16}$	23·812286
1	25·399772

μ	ins.
1	·000039
2	·000079
3	·000118
4	·000157
5	·000197
6	·000236
7	·000276
8	·000315
9	·000354
10	·000394
11	·000433
12	·000472
13	·000512
14	·000551
15	·000591
16	·000630
17	·000669
18	·000709
19	·000748
20	·000787
21	·000827
22	·000866
23	·000906
24	·000945
25	·000984
26	·001024
27	.001063
28	·001102
29	·001142
30	·001181
31	·001220
32	·001260
33	·001299
34	·001339
35	·001378
36	·001417
37	·001457
38	·001496
39	·001535
40	·001575
41	·001614
42	·001654
43	·001693
44	·001732
45	·001772
46	·001811
47	·001850
48	·001890
49	·001929
50	·001969
60	·002362
70	·002756
80	·003150
90	·003543
100	·003937

POLLEN-TUBES.—It is well-known to every one who has undertaken a systematic investigation of any subject, that it is not only exceedingly difficult to find out anything new, but even to verify or disprove the results obtained by others is no small task.

In the investigation of the process of fertilization of flowers, it is necessary to follow the course of the pollen-tubes after they penetrate the stigma until they end. This must be done by cutting thin sections of the pistil containing the tubes in such a way that their course can be traced under the microscope. The difficulty of doing this must be very great, as any person who uses the microscope will readily understand. It is not strange, therefore, that there should be some differences of opinion among botanists as to the course of the pollen-tubes.

While some maintain that they penetrate the stigma, and pass down through the style until they reach the ovules, others assert that this is not proved. Mr. Kruttschnitt, of New Orleans, whose articles on this subject deserve attention from botanists, has tried in vain to follow the pollen-tubes down to the ovary in any plant. He has, therefore, concluded that fertilization does not take place in the way usually taught in the books.

From what Mr. Kruttschnitt has written to us privately, we are inclined to think he has received but little encouragement in his work from eminent botanists. Surely, it is an important subject, and no one who reads what Mr. Kruttschnitt has written can deny that he has good reasons for rejecting the opinion now prevailing among botanists. Is it possible that some of our eminent botanists do not care to learn the truth of this matter? For our own part, we trust Mr. Kruttschnitt will continue his investigations. We would also commend the subject to microscopists generally as one worthy of their study, and which will put their skill in making their sections to a good test.

THE CORTEX OF CHARA.—The April number of the *Bulletin of the Torrey Botanical Club* contains a valuable contribution on the "Development of the Cortex in Chara," by Dr. T. F. Allen, of this city, who is well-known as a student of the Characeæ. According to the present most approved system, the classification of these plants is based upon a knowledge of their morphological characteristics. The study of the development of the Cortex, and of the relations of nodal cells is, therefore, important and of great use to the botanist. Dr. Allen has given a very full account of the most notable characteristics of the cortex in many species, with illustrations on seven plates, one of which is printed in color. The manner in which the cortex and the leaves develop from the circlet of cells about the node, is very clearly explained, and although at best the structure of the cortex has always seemed to us difficult of comprehension by any person who has not studied the plants themselves, we are inclined to regard this article of Dr. Allen as affording a better idea of the matter than any other we have seen.

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THE AMERICAN SOCIETY OF MICROSCOPISTS.—We have received a letter from Dr. Gleason, of Elmira, in which he refers to the coming meeting of the American Society of Microscopists, to be held in that city next August, as promising to be a large and interesting meeting. No doubt it will be, if the efforts of an active and well-known local society will suffice to accomplish such a result. We are confident that no pains will be spared for the good entertainment of guests, and that all who attend the meeting will be pleased with the arrangements and the subjects discussed.

The President of the Society, Dr. Blackham, of Buffalo, has issued a circular giving such information as those who intend to be present at the

meeting should have. Committees are to report on eye-pieces, on revision of the constitution, and on "the question of a quarterly journal." We trust the report on eye-pieces will be carefully prepared. That committee has a work of responsibility in charge, and while a thoroughly sensible report on the subject may result in much benefit, a hasty, ill-considered report will do more harm than good.

It is to be hoped that the constitution of the Society will be satisfactorily arranged this year.

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PHYSICIANS AS MICROSCOPISTS.—The *Medical Register* does not agree with the opinions expressed some time ago in these columns, as regards the "lamentable ignorance concerning the microscope among" physicians. The writer attempts to refute our conclusions by stating that the best books we have on microscopy are written by physicians. The question is not of who writes the books, but who reads them. Is the entire medical profession to bolster itself up in this matter, because half-a-dozen of its members are eminent microscopists?

Why should not the *Medical Register* admit the fact, which almost everybody knows, that medical education in this country is, in most institutions, a mere farce. Instead of flattering its readers into good humor, by telling them they are pretty good fellows after all, and can rely upon Beale and Carpenter and half-a-dozen others to keep up the credit of the profession as microscopists, why not "pitch into" the medical colleges and make them teach histology with microscopes, and thus try to do some good in the world?

We have to thank the *Buffalo Medical and Surgical Journal* for a very courteous notice of our paper. We would be glad to know that it was as well appreciated by the medical press in general.

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DOUBLE STAINING OF BLOOD-CORPUSCLES.—We have already called attention to the fine slides of double-stained blood-corpuscles prepared by Dr. Allen Y. Moore, which were shown to us by Mr. Woolman. The preparer has now given his process in *The Microscope*, and a gorgeously colored plate, showing several kinds of blood-corpuscles stained, accompanies the article. In brief the process is as follows: The blood is evenly spread in a thin film on the slide, and dried, in the usual manner. It is then covered with a solution containing eosin 5 grains, water 4 drachms, alcohol 4 drachms. In about three minutes this is washed off in a glass of water, and without drying a solution containing methyl-green 5 grains, and 1 ounce of water is flowed over the slide. In about two minutes the slide is washed, dried, and the corpuscles preserved in Canada balsam.

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STAINING BACTERIA. — Dr. Ehrlich, assistant of Prof. Koch, has devised a method of staining the bacteria of tubercle, which is said to be much superior to that of Koch, who has has himself adopted it.

The bacteria of tubercle, like all micro-organisms, are stained by anilin colors. Koch employed an alkali —caustic potash—to penetrate the cellulose coat of the bacteria, but as this alkali-acts strongly upon various histological elements, and also upon the bacteria, Ehrlich has used as a substitute for it phenylamine, or anilin (anilin-oil).

A solution of phenylamine in water is prepared, and a saturated solution of fuchsin, or methyl-violet, is added to it until a slight opalescence is produced. The material to be stained is dried on the cover-glass and then stained by the solution, which requires about a quarter of an hour. The entire specimen is thus stained intensely. To demonstrate the bacteria, the color is discharged from parts of the preparation by acid. Nitric acid diluted with twice its volume of water is used.

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THE SALMON DISEASE. — Prof. Huxley contributed an important paper to the Royal Society a few months ago, on The Salmon Disease. In certain rivers the fishes are affected by an epidemic disease, which manifests itself in white patches upon the fish where there are no scales. As the fungus grows, a sore forms which may extend to the bone.

The fungus is a *Saprolegnea* probably *S. ferax*, but of this there is no proof. The zoöspores from this fungus were never observed ciliated and motile; but they are exceedingly minute, and become rapidly disseminated. They are produced in great numbers—a single fly infected with the fungus may bear 1,000 fruiting hyphæ, which, in one day may produce 40,000 zoöspores.

The hyphæ seem to not only traverse the epidermis of the fish, but also to bore through the superficial layers of the derma. The epidermis is entirely destroyed.

The only method of preventing the spread of this fungus among salmon, is to remove every infected fish from the stream, though it may not be worth while to adopt this method in practice. Although sea-water kills the fungus when it comes in contact with it, if the latter has penetrated the derma the fish may go to the sea and recover from its attack, but on returning to fresh-water, the disease may break out again from the hyphæ in the derma.

NOTES.

—The local committee having charge of the arrangements for the meeting of the American Society of Microscopists to be held in Elmira, beginning August 15th, have been appointed, and are busy in preparing for the meeting.

Mr. C. N. Shipman is Chairman of the Reception Committee. The Secretary of the local society is Dr. T. S. Up de Graff.

—The bacillus of leprosy, which has been described by several authors, but concerning the existence of which there is some dispute, has been found by Dr. I. Bermann, of Baltimore, who describes his method of examination in an article which s illustrated by a cut—published in *Archives of Medicine*.

The author believes that others have failed to find the *Bacillus leprae* because they have not adopted the proper methods of staining the leprous tissues. The article should be read by those who are engaged in the study of bacteria in tissues.

—Mr. Vorce informs us that the new Bausch and Lomb $\frac{1}{8}$ and $\frac{1}{8}$-inch objectives, which, it is claimed will resolve 152,000 lines to the inch, "easily resolves the balsam *Amphipleura pellucida* with mirror exactly central, using sunlight and no condenser." He says, "the resolution is got instantaneously, as easily and as quickly as $\frac{1}{4}$-inch resolves *Navicula lyra*."

—A very interesting article on "The Structure and Division of the Vegetable Cell" was published in the March number of the "Journal of Quekett Microscopical Club," by W. H. Gilbert, F. R. M. S. There is a plate illustrating the process of division. It is a most excellent article for botanists to study.

CORRESPONDENCE.

TO THE EDITOR:

I wish to enquire through the columns of your JOURNAL, if the "stephanoceros" is plentifully found in this country? If any of your readers can inform me through the columns of your JOURNAL, they will greatly oblige

H. H. DAVISON.

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TO THE EDITOR:—Will you have the kindness to inform me what are the best media for mounting plant-hairs and glands; also micro-fungi, stating best method of preparing these objects for mounting? Many of the micro-fungi are upon leaves.

E. P.

[Plant-hairs may sometimes be mounted in balsam, especially those which are displayed well with the polariscope; but in most cases glycerin-jelly will be found more suitable. The leaf glands are usually best seen when the specimens are stained and mounted in balsam. The minute fungi on leaves will probably be seen best in opaque specimens, mounted dry.

We can hardly give satisfactory directions for preparing the specimens in this place,

but if our correspondent desires information about any particular one we will endeavor to indicate the proper course.—ED.]

MICROSCOPICAL SOCIETIES

At a meeting of the Microscopical Section of the ACADEMY OF NATURAL SCIENCES, of Philadelphia, held May 1st, Mr. Edward Potts spoke on the fresh-water sponges and their classification.

By the use of a number of excellent instruments kindly provided by the members of the Section, Mr. Potts was enabled to exhibit a collection of fresh-water sponges, unique in the possession of many new species never before exhibited. Cabinet specimens in boxes, and others prepared for microscopic examination were shown, covering all the recognized genera of this group of organisms, and probably a majority of all species yet described.

Mr. Potts began his remarks by saying, that the classification of sponges had been very imperfect in most respects, excepting the lime sponges, which are marine, although it is not at all improbable that fresh-water lime sponges will yet be discovered. The fresh-water sponges so far as known at present, are silicious. They merge into the keratose or fibrous variety. The spicules are held together by sarcode. The essential difference between fresh-water and marine sponges is that the latter are reproduced by eggs, but eggs of the former, have not been found. The reproduction is by statospheres or seed bodies—formed at different times, sometimes early, sometimes late. Many of the *Spongilla* are branched, others are simply a film upon stones, etc.

Until very recently, the fresh-water sponges have been grouped under the single genus *Spongilla*. In the spring of the year 1881, however, Mr. Carter revised their classification, and arranged them under five generic heads, three of which are found to have numerous representations in this country; and two others apparently peculiar to North America have been added.

This classification is based upon the characteristics of what may be called the third class of spicules, or those pertaining to the statospheres or winter eggs of the sponges. The genera may named and briefly described as follows :—

1. Spongilla.—Spicules of the statosphere acerate (needle shaped), straight or curved, smooth or spined, lying upon the chitinous coat.

2. Meyenia.—Spicules birotulate, that is, consisting of two wheels or disks, connected at their centres by a short shaft.

3. Heteromeyenia. — Spicules in two series, one of which resembles that of the last genus; the other is composed of interspersed spicules fewer in number and about twice the length of the former; generally terminated by strong, recurved hooks.

4. Tubella.—Spicules inequibirotulate, the outer rotule, or disk, having been reduced to a fraction of the diameter of the other.

5. Parmula.—In this the outer disk has become entirely eliminated, leaving the spicules to appear as a series of cones terminated by sharp points.

6. Carterella.—The form of the spicules in this would place the species amongst the meyenia, but there is superadded a feature not yet observed in connection with any sponge of the old world, which demands for it a distinct generic position. This is the possession of a number of cirrous appendages resembling long, curling or twisted tendrils, which are extensions of the chitinous coat of the statospheres, mostly from the neighborhood of the foraminal aperture.

The remaining genus can hardly be said to be well defined, as no statospheres, have yet been discovered.

Mr. J. O. Schimmel then exhibited a slide containing the flower of *Chrysosplenium Americana.*

This delicate flower which is apparently devoid of beauty, when viewed by the microscope, presents one of the most interesting and beautiful objects that can be shown.

Mr. Jacob Binder, exhibited four specimens of the legs of beetles belonging to two genera of the Coleoptera, *Dytiscus marginalis*, and *Arcelius mediatis* from the Hammondton ponds of New Jersey, and *Arcelius fraternus*, a European species.

These objects were intended to show the formation of the sucking-cups, found upon the forelegs of the different varieties. They are only upon the forelegs, except in the case of the *Dytiscus marginalis*, where they are also found upon the middle legs in a less developed condition. These suckers are sufficiently destinctive in their character to assist the entomologist in their classification.

The function of these organs seems to be to facilitate the males in adhering to the female during sexual intercourse.

Mr. Binder, called the attention of the members particularly to objects of this kind not that he claimed a new discovery, but because they are so easily obtained and requiring very little skill in their preparation. Microscopical specimens of rare beauty, interest, and instruction can be obtained. The suckers are not the only objects of interest to be found upon the beetles. By dissection, the spiracles and the branchial trachea of the respiratory apparatus can be shown, and when these objects are made sufficiently transparent, it is possible to show the tracheal tubes within the boring case of the legs surrounded by their delicate spiral covering.

At a meeting of the NEW YORK MICROSCOPICAL SOCIETY, held May 19th, the subject of "Illumination of Microscopic Objects" was discussed. The President, Mr. Braman, opened the subject by stating the importance in microscopical investigation of careful attention to the intensity and direction of the illumination. Mr. Hitchcock, was then called upon to speak on the subject. Referring to some remarks of the President, he stated that the best objectives for the study of bacteria, were not necessarily lenses of excessive aperture. The flagella of *Bacterium* were discovered by a Powell & Lealand, wide-angled ⅛, but afterward seen by the same observer with a $\frac{1}{16}$ of moderate angular aperture. He stated that the difficulty of defining such organisms as bacteria was mainly in the proper adjustment of the light; not so much due to imperfections in the objective, as to the manipulation. The secret in defining bacteria was to have light of sufficient intensity condensed upon the exact point where it is most effective. He stated that there was a very simple and interesting problem, which has puzzled many microscopists of late, to which he would call attention by the aid of a diagram on the black-board, and endeavor to explain without the aid of mathematics. It is, perhaps, not easy to understand how the immersion-fluid affects the resolving power of a lens, while it does not change the angular magnitude of the cone of light. It is clear that with a front-lens ⅛ of an inch in diameter, with a given working-distance, the angle included between the focal point and the extremities of the diameter of the lens, will be the same, whether in air or water, or any other medium. The angular magnitude is always the same, but by the interposition of a medium denser, than air in front of the objective, some of the rays which in air passed outside of the angle, and which therefore could not enter the objective, are refracted so as to reach the front lens. Hence a greater number of rays enter the lens, although the angular magnitude remains the same. The illumination is, therefore, better, and the resolving power is increased, since the wave-lengths are shortened by the denser medium.

Numerical-aperture indicates the relation between focal length and aperture. It also indicates the resolving power of an objective in a very simple way. Taking the wave-length of green light as $\frac{1}{50000}$ the resolving power in lines to the inch is given by the product of the numerical aperture multiplied by 1,000,000 (n. a. × 1,000,000).

Mr. William Wales, being called upon, said that it was the aim of the optician to constantly improve his objectives, and it remains for microscopists to determine what they will do. While microscopists are constantly demanding better lenses, it should be known that great skill is required to obtain the best results with the lenses that are produced. He made a lens long ago that would resolve the *A. pellucida*, but it was two years before the resolution was effected, because proper manipulation was wanted.

Mr. Dinwiddie, showed a specimen of "Peley's hair," a volcanic product from the Hawaiian Islands, which he stated to be full of elongated cavities, and crystals.

Mr. Kunz, made some remarks about a similar product from blast-furnace slag.

Mr. Balen, showed some pond-life, *Plumatella*, newt tad-poles, etc.

NOTICES OF BOOKS.

Sea Mosses a Collector's Guide and an Introduction to the Study of Marine Algæ. By A. B. Hervey, A. M. Boston: S. E. Cassino, 1881. (Pp. 281, and 20 colored plates).

The author of this book is well known to the microscopists of the country as a graceful speaker and writer, as well as an enthusiastic student of the algæ. In the Introduction he declares his purpose in writing it, to be to afford a "convenient and competent guide" for beginners in

this study. Careful reading will convince any person that he has succeeded most admirably. No one could write a book like this, without a thorough knowledge of the subject, and a sincere interest in the work, such as Mr. Hervey certainly possesses.

In the Introduction, is given advice about collecting and preserving specimens of marine algæ, and arranging them for the herbarium, with other useful information. The succeeding chapters relate to the study of the plants. Each chapter opens with a "key to the genera," and the species are then fully described in plain language, without the use of scientific terms. Each plate represents a characteristic species of the genus in the natural color of pressed specimens, many of which will be instantly recognized by those in the least familiar with our most common forms. No attempt is made to carry the information beyond what the amateur collector requires for naming the specimens that may be found, but there is sufficient for this purpose. The book will surely be the constant companion of a large number of people who visit the sea-shore this summer, and it will well repay careful perusal. It is not saying too much to add that it is one of the very few books designed to make scientific studies popular and attractive, that fulfills their purpose well. No reader of this JOURNAL should visit the sea-shore, without a copy of this book. It is written in a good style, is well printed and the binding is artistic.

Civilization in its Relation to the Decay of the Teeth. By Norman W. Kingsley, M. D. S., D. D. S., etc., etc. New York: D. Appleton and Company. (Pamphlet, pp. 10.)

A concise and clear statement of speculative and fallacious ideas concerning the increased decay of teeth prevailing in later generations. After stating and contradicting these theories, he shows how the effects of refined and luxurious life in the strain of mental labors upon the nervous system, diverts the nutrition of the body to repair waste of nervous tissues, and fails to build up muscular or dental growth, or to sustain it. Hence nervous diseases and "caries" are greatly upon the increase. Proper nutrition being withdrawn, teeth are more susceptible to external agencies; and for the same cause, new generations inherit an enervated condition, which includes poorly organized teeth. The remedy lies in lessening care and anxiety, in giving more attention to hygiene and habits of living. To sum up; the secret of nervous exhaustion and teeth-decay, lies not in work but in worry.

E. C. H.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

On receipt of a well-mounted slide, I will send a slide of crystal, (for the polarizer) of any of the rare vegetable products which I may have; will send list of same on receipt of postal request.
J. KETCHUM, Jr.,
P. O. Box 877, New York City.

Wanted. — Animal parasites, Ixodes, Acari, etc., either mounted or unmounted. W. A. HYSLOP,
22 Palmerston Place, Edinburg, Scotland.

Mounted slides of Selenites for the Polariscope, in most beautiful and brilliant colors, in exchange for first-class Histological and Pathological slides and slides of diatoms, algæ, etc.,
A. C. GOTTSCHALK,
193 North Salina Street, Syracuse, N. Y.

Unmounted objects, Foraminifera, Spicules, Plant-hairs, Zoophytes, etc., in exchange for other objects, mounted or unmounted.
E. PINCKNEY, Dixon, Ill.

Wanted—First-class mounts of double-stain vegetable preparations in exchange for first-class insect preparations. H. S. WOODMAN,
P. O. Box 87, Brooklyn, E. D., N. Y.

Wanted—First-class prepared and crude material, or mounted objects, in exchange for diatoms *in situ* or other first-class crude material, or for mounted objects.
M. A. BOOTH, Longmeadow, Mass.

Niagara River Filterings for mounted slides.
H. POOLE, Buffalo, N. Y.

Wanted—Good gatherings of Diatoms, fossil or recent, especially of test forms. Liberal exchange in fine slides; prepared or rough material. Lists exchanged.
C. L. PETICOLAS, 635 8th Street, Richmond, Va.

Good, uncleaned Diatomaceous material containing *Arachnoidiscus*, *Heliopelta*, *Pleurosigma*, *Isthmia*, *Triceratium*, *Surirella gemma* and *Terpsinoe musica* wanted, in exchange for well-mounted slides of arranged diatoms, etc., or cash.
DANIEL G. FORT, Oswego, N. Y.

Well-mounted Histological and Pathological slides in exchange for other *first-class slides*.
LEWIS M. EASTMAN, M. D.,
349 Lexington Street, Baltimore, Md.

For exchange: Mounted thin sections of whalebone, soapstone, serpentine, albite, feldspar, etc.; also opaque mounts of several very beautiful fossiliferous limestones.
Rev. E. A. PERRY, Quincy, Mass.

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The Protista.*

BY E. HÄCKEL.

A good negative criterion to characterize the protista as regards animals and vegetals, is that they possess neither a gastrula with its two germinative layers, like the former, nor a thallus or prothallium, like the the second. It may be added that the protista never have veritable tissues (constituted by a large number of associated cellules) nor organs, like all animals and vegetals. Finally, it is particularly necessary to note that the great majority of all the protista are produced by asexual generation (scissiparity, budding, spores). Even among the small number of protista which have already attained to the most simple form of sexual generation, there never exists between the male and female a distinction so marked as among the animals and the vegetals. In this regard they are the representatives of the earliest degree of inferior development which existed prior to the evolution of plants and animals.

If we knew exactly how organic life developed from its origin upon our planet, how the animals, the protista and the vegetals appeared for the first time, we might form a clear and certain judgment upon the relations between the three realms. But the path which conducts us to the immediate knowledge of this great problem is eternally closed to us. No living creature, no document of creation, can relate to us how, millions and millions of years ago, life developed. Thousands of species and genera, millions of generations, have fallen into the abyss without having left the slightest trace of their existence. And precisely the more important for us of all these creatures, the forms most ancient and the most elementary, have left no fossils, their bodies being destitute of hard parts.

But, if we cannot, by the experimental method, attain any knowledge of this great question of origin, it is permitted us here, as in other cases, to fill the irremediable lacunes of our science by scientific hypotheses. If that "historical hypothesis" is founded upon facts that science has hitherto established, it is as firm, as justified in natural history, as it would be in geology, archæology, in the history of civilization, or in any other historical science. And as the hypotheses generally recognized have conducted us to a satisfactory understanding of the development of our globe, so the phylogenetic hypotheses which are based upon the theory of descent reformed by Darwin, explain the development of organic life upon the earth.

We cannot dwell upon the examination and the proofs of all the divers phylogentic hypotheses which have been proposed to explain this development. We will consider at least one idea which to-day seems to have great probability. One must admit that life began upon this planet by the spontaneous formation of the most simple protista at the bottom of the combinations of inorganic matter. These living creatures, of antiquity so great, must have resembled the moners which exist to-day, exceedingly simple masses of protoplasm

*Abstract, translated for this JOURNAL from the French. *Jour. de Phot. et de Micr.*

without the least organization. From them have been formed, by the differentiation of an intestine in the interior, unicellular protista, cellules of elementary simplicity, amorphous and indifferent, resembling the amœbæ. Some of these unicellular protista being possessed of social inclinations, are accustomed to live united in small colonies; the earliest polycellular organisms appeared first as simple cellular aggregations, associations of homogeneous cellules united by very lax bonds. It is, indeed, probable, that these very ancient beginnings of the evolution of organic life were repeated in many different parts of the earth, then in its youth, at the same time and in an independent manner. In this way divers, and it may be many, varieties of protista may have been born isolated from each other, first unicellular, afterwards polycellular. Owing to the struggle for existence, which began even among the protista with the aurora of life, these creatures advanced, little by little, to a superior grade of differentiation and perfection. The most important advance was indisputably the reciprocal separation of the vital processes of animals and plants. Among these protista, some began to adopt themselves to a mode of living which has become that of animals, others to a kind of existence which is that of vegetals, and the characteristic form of the bodies of these creatures resulted from these adaptations. A third group of protista, a conservative group, maintained its original neutral character. While these divers adaptations were becoming fixed in the course of centuries by heredity, the three grand organic kingdoms were completing their development.

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Ernst Gundlach's Substage Refractor.

This apparatus, which is designed for the measurement of the angular apertures of wide-angled objectives, consists of a small crown-glass cube with sides of about $\frac{3}{16}$ of an inch. One of its surfaces is made opaque, the one opposite to this, and also the two others opposite each other, are polished. The cube is made to adhere, by means of a suitable homogeneous medium, to the front surface of the objective the angular aperture of which is to be determined, by the polished surface opposite the opaque side. Then a ray of light must enter each of the polished side surfaces in the plane described by the optical axis of the objective and a line perpendicular to those polished surfaces, and at such angular inclination to the optical axis that it will pass through the objective close at the edge of its aperture, and emerge from it in the direction of the optical axis.

The angle described by the refracted rays inside of the crown-glass cube, is equal to the crown-glass angle of aperture of the objective and is:

$$\cos. n = \cos. \frac{a}{r}$$

a being half the angle described by the two light-rays before entering the crown-glass cube, r the refractive index of the crown-glass, of which the cube is made, n the crown-glass angle of the objective.

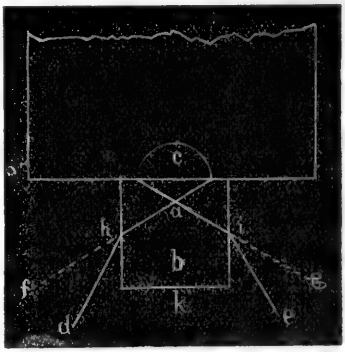

FIG. 35.

The accompanying diagram may serve to make the principle more easily understood: c is the front lens of the objective; b the crown-glass

cube; *k* the opaque surface; *d h* and *e i* are the light-rays that enter the glass cube at *h* and *i*. These rays are refracted in the direction of *f a* and *g a*, pass through the objective close at the edge of its aperture, and emerge from it in the direction of the optical axis; then *f a g* is the crown-glass angle of the objective.

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Life-histories and their Lessons.

BY THE REV. W. H. DALLINGER, F.R.S., F.R.M.S.

[The *Northern Microscopist* of July has an article with the above title, by the Rev. W. H. Dallinger, F.R S., F. R.M.S., which is to be continued in the August number. The article is too long for reproduction in these columns, and it requires the use of plates. The reader who desires to follow the observations described by Mr. Dallinger, is referred to the original, but all will be interested in the introductory remarks, which we reprint below.—Ed.]

This paper is extremely simple in its aim. It was written (with no intention to publish) at the request and in the interests of a large number of microscopists and amateur students of the phenomena of life, as seen in the flora and fauna of our ponds, ditches, and sea-side, as well as in septic fluids. Some industrious observers amongst them had, from a desultory method of observation, of necessity, met with paradoxical phenomena. The products of pond and ditch were placed for an indefinite time in "live boxes," kept as long as possible from evaporation. The results were the inevitable commingling of life and death; the destruction or decomposition of one set of forms providing nidus and pabulum for quite another. In all probability the life-histories of none were really known, and parasite, epiphyte and septic organisms succeeded, or were concurrent with, each other. The possibility of erroneous interpretation in such a case is immense, specially when the "observation" is broken and occasional. The result has been, that ardent minds have endeavored to show that some of the issues observed were only to be accounted for on the hypothesis of "Heterogenesis."

Some of the cases appeared striking; and at the instance of a large number, who thought good service might be rendered by it, I have taken a series of similar or corresponding instances to interpret the anomalies, and show that "Heterogenesis" is no part of the phenomena of minute life when studied with sufficient care and continuity. It is in deference alone to the strongly-urged request of these that the discourse is printed.

We have, frequently, during the past few years, had our attention called to apparent anomalies in minute organic forms and minute organic processes. In these, besides the portraiture of what were considered the "facts," there has been an attempt made to show that along the border and margin where life manifests itself on this earth, amongst its minutest developments and least organized products, there is uncertainty of developmental action:—either no law at all, or if there be law, that we are wholly without knowledge as to its character; and that it must be unlike the laws which we know are in constant and unvarying operation where our knowledge of vital processes is absolute and complete.

Now, it must be remembered that by the modern microscope a realm of life and organization is opened to us almost infinite in its extent and variety; and increased optical power, instead of exhausting, only widens out, intensifies, and renders it more entrancing. But as it required the aid of moderate lenses to understand exhaustively the mode of life and methods of growth of an oak tree—large as it is—so it must require the magnifying power of our most perfect and powerful object-glasses to discover the modes of life, methods of meta-

morphosis, and manner of origin, of the immeasurably lesser forms, which are not seen at all until the lens needful to discover the germination of an oak tree is used. As we pass downward, we come to less and still lesser forms, all equally endowed for, and adapted to, their environments. But as we come to the more and the most minute of the organic forms in nature at present discoverable by us, we come upon forms that multiply with inconceivable rapidity; many of them will, by one process of multiplication alone, produce, in the course of three hours, as many individuals as there are human inhabitants on the surface of this earth; and in a paper read only a few days ago, in the French Academy of Science, M. Pasteur, proposing to destroy Phylloxera by fungoid growths, said: "The extraordinary multiplication of Phylloxera is a mere trifle compared with the power of life and propagation of certain parasites. The Hall of the Academy of Science . . . is pretty large: it has hundreds of cubic metres of capacity. I would undertake," said Pasteur, "to fill it with a liquid of such a nature, that by sowing in it a microscopic organism, the whole of the immense vessel would in a few hours, be troubled with the presence of the parasite, and in such great abundance, that all the *Phylloxeras* in the world, compared in numbers to the individuals of the parasite, would be like a drop of water in the sea." But their *modes* of multiplication, in their completeness, are either defiantly beyond our present powers of research, or if here and there known at all, they have to be very patiently, persistently, and with the highest powers of the microscope worked out.

Now, whoever engages in this work will learn many things indicative of caution, and will be slow indeed to make hasty inferences.

There happens to be, however, a fine army of such workers in the world just now; men who, with all the necessary mental endowments and training, are, with the most splendid lenses the world can produce, working amongst the mazes of this wonderful margin and edge of living things. They are trying to individualize the components of the apparently confused mass, and make out the life-histories of the minutest of living things. And they are slowly succeeding. Life-history after life-history is being drawn by resolve and patience from the depths of the confusion:—and with what result? Every where, where the work has been exhaustively done, with the affirmation that biological processes amongst the least and lowest living things are as orderly rigid, and within certain limits as capable of predication, as amongst the butterflies or the entomostraca.

There are men, forever working amongst the forms of life, similar to, or identical with, those brought before us in the papers the inferences of which I seek to controvert. But they use far higher magnifying power, and pursue another method of research essentially exact; do they reach the same results? Do they infer that one form of minute life may transform itself into another? That the protoplasm from a cell of Chara or Nitella may become, of its own caprice, or by some hidden law, and without the intervention of parent or egg, a Paramæcian?

Verily, no! The testimony of Balbiani, Pasteur, Van Beneden, Bütschli, Fol, Häckel, Huxley, Pelletan, Asa Gray, Louis Agassiz, H. J. Clarke, W. Roberts, Balfour, Ray Lankester, Ewart, and a host of others is unanimous—and it is this—that wherever we work out a minute life-history thoroughly, we come upon as orderly a process of nature as in the development of a frog or the growth, from its fertilized germ, of a primrose.

All this of course is no reason why others should not find what is, or what seems to be, uncertainty or caprice in the lower strata of vital action in nature. Only that they should do

so, implies a method of research inconceivably higher and more analytical, than that adopted by these leaders of research in minute biology; or else it can be explained as error arising from a method not competent to cope with the conditions of the problem.

Approach the question of vital action as displayed by protoplasam fairly. What is that in nature which, above all things, impresses us as we study the phenomena, and the results, of her countless cycles of activity? The stability of her processes; and the mathematical precision of her action. Does any one doubt the invariable and inviolable nature of the laws that control chemical combination and physical phenomena? Would any amount of paradox or perplexity that might arise in complex experiment induce a man to believe that the proportions of carbon and oxygen which constitute carbonic acid are uncertain and capricious? or that the combining proportions of oxygen and hydrogen are very uncertain in the synthetic production of water?

If you heat a bar of platinum under certain fixed conditions, on two following days, you do not expect that it will indicate different powers of expansion, or melt at a lower temperature to-day than yesterday. A given musical note will depend on the same number of vibrations tomorrow as to-day.

Yes. But it may be said all this applies to the inorganic world. Is it true of that which lives? Properly understood, I profoundly believe it is.

What do we know of life? Only this with certainty:—that wherever you have life it is inherent in a definite compound. This compound has special and unique properties. But wherever you find it as *protoplasm* in the sense in which I use that word, it exhibits the properties of life, and you will nowhere find the properties of life except associated with, and inherent in, protoplasm.

Now, has this protoplasm an ascertainable composition? Yes; you can analyze it chemically—that is when it is dead—and it is found that its chemical elements are everywhere practically alike. To say that the life-stuff of the lowest fungus, and that of the most powerful human brain, are identical, is, there is no doubt, in some sense, absurd; it is abuse of language; they, without question, differ inconceivably. But if you consider only the chemical composition, and discoverable physical properties of protoplasm from a mildew, or protoplasm from the apparatus of human thought, they are alike. Their difference is potential and not physically manifest. Then we may ask, "How, and in what, do matter living and matter not living differ?" In their properties—and in these they differ as the finite and the infinite differ—absolute and wholly. We may not dwell upon what they are; but we may add that even the chemical reactions of living protoplasm are quite different from those of the substance which repreresents the protoplasm, when its life is gone.

Professor Huxley writes concerning protoplasm thus:—"The properties of living matter distinguish it absolutely from all other kinds of things; and," he continues, "the present state of our knowledge furnishes us with no link between the living and the not living."*

Then, so far as the evidence will carry us, there is to-day in our laboratories, and in our facts from nature, no evidence of the existence of spontaneous generation—no phenomena that prove, or even suggest, that what is not living can, without the intervention of living things, change itself into that which lives.

The masters of biology agree that there are none. Only that which is living can produce that which shall live. Dissociated molecules of lifeless matter, with no vital affinity to marshal them, are, as a matter of fact,

*Encyc. Brit. vol. iii., p. 697, 9th ed.

never seen to endow themselves with the properties of life.

Dealt with physically, it has, as a question, received masterly treatment at the hands of Tyndall, and his answer is emphatic—it is, that that which is not living does not rise to that which lives.

Biologically, it has been dealt with by all the workers in minute biology, and their answer is, that as far down as we can reach, or see, with certainty, living things arise ultimately in living products—parental germs or spores—the equivalents of eggs or seeds.

"But," says the shallow reasoner, "if there be no spontaneous generation in nature, how can we have consistency in the great doctrine of evolution? That process must have been a march of mighty progression from the beginning until now. Evolution is in danger by your facts! I answer, if that be so, then I prefer the facts, to the doctrine of evolution. But I affirm that such reasoning is wrong, and Professor Huxley shall give the answer. If once, in the mighty activities of the evolving past, dead matter was at some point of crisis and necessity changed into that which lived, and one of its properties was the capacity to multiply itself indefinitely, why do we need the *constant* change or transmutation of that which is dead into that which is living to-day?

Says Huxley: "If all living beings have been evolved from existing forms of life, it is enough that a single particle of protoplasm should have appeared on the globe, as the result of no matter what agency; in the eyes of a consistent evolutionist any further independent formation of protoplasm would be sheer waste."*

Then the facts are:—1. That protoplasm or "bioplasm" is a certain definite compound possessing the properties of life.

2. That life is nowhere found without it.

3. That only living matter can produce living matter.

Now, I ask, do the stability and precision discoverable in the operation of chemical and physical law, as applied to non-living substances, hold good in the operation of the discoverable laws of biology? I maintain that they do.

One error often entering into a discussion of matters concerning protoplasm, is to suppose that we are discussing an abstract thing. Who ever saw abstract protoplasm? There is no such thing. You may have the protoplasm of an alga, or of a trout, or of a man; but you cannot have protoplasm that belongs to nothing. As there is no abstract matter discoverable by us, so there is no abstract protoplasm. You may have matter endowed permanently with the properties of gold, or silver, or hydrogen; but the matter common to and underlying them all is not discoverable.

You must, therefore, if you have matter at all, have it specialized, endowed with certain properties.

It is so with protoplasm. It is never within our reach as an unspecialized compound. We know it as the protoplasm of a mushroom, or an oak, or an amœba, or a sparrow, and therefore with the special properties belonging to that and to nothing else.

Living stuff is the product of living things. Living things are developed according to known and discoverable laws, as rigid as those which determine the composition of carbonic acid or chloride of sodium, only more complex.

* *Encyc. Brit.*, vol. iii., p. 689.

A New Microscope.

We illustrate this month a new microscope-stand by J. Grunow, of this city. It is of brass, with the exception of the base which is japanned. With the draw-tube down, in the vertical position, it is twelve inches in height. With two oculars, a 1-inch and a ¼-inch objective, and double

nose-piece, the stand sells for $105.00.

Mr. Grunow states that in making this stand he has endeavored to meet the wants of those who desire a well-made stand at a reasonable price. He has, therefore, given great attention to the workmanship, and has modeled it so as to save all possible cost in manufacture. It is a stand especially adapted to physician's work.

FIG. 36.

The cut renders a detailed description unnecessary.

Fresh-water Algæ.

The April number of *Hedwigia*, a botanical journal published in Leipzig, contains an elaborate article on the question, "Is *Spærozyga Jacobi* a synonyme for *Mastigocladus laminosus?*" Although the author bestowed much care and patience upon the examination of his dried specimens to prove that the two forms are different plants, yet he utterly failed to convince us that his deductions are correct. To meet his ingenious arguments would require better opportunities than it has been our privilege to enjoy for the study of the life-history of the so-called *Mastigocladus.* A sojourn at Karlsbad, the habitat of the form in question, and the exercise of the patience of a Dr. Itzigsohn to watch its development and growth for a year or two might be needed. It is not enough to know that one author and another naturalist found it in the same waters, and in nearly the same condition; but it is also interesting to learn that the collectors and students obtained something which none of them appeared to understand. Our author himself acknowledges "there is a labyrinth of synonymes." There seems to have been something very vague about the forms; one pronounced the plant *Anabæna*, another a *Nostoc;* one author hazarded the opinion that it was a *Sphærozyga;* Kützing called it a *Merizomeria*, then a form of an alga corresponding to his *Cylindrospermum licheniforme;* Cohn made of it a new genus under the term *Mastigocladus.*

The critics were, every one of them, close observers, but the diversity of conditions due to different stages of development gave rise to diversities of opinion.

To us the simple appearance of *Mastigocladus laminosus*, as figured, is sufficient to explain the mystery about it. All the features are those of developing forms—the somewhat irregular cell-forms of the trichoma, some spherical, some oblong or oval, and others cylindrical, and then the more elongated articulations of the pseudo-branchlets are features common to the early stages in the development of many filamentous algæ.

During the infancy of the study of

the fresh-water algæ the error committed by the author was unavoidable, but such errors are now less excusable, since we have learned more of the life-history of these plants, of the singular transformations they undergo in a kind of intermediate existence, or arrested development, a condition between the embryonic microspores and the perfected plants—a condition which often continues for months, during which time they assume various forms, most commonly unicellular forms—which have given rise to numerous false genera.

Our lamented friend the late Dr. Rabenhorst, of Prussia, published a most valuable summary of the fresh-water algæ, which included the names and descriptions of all forms known up to the date of his publication. He performed a noble work, but more exact information acquired in later years reveals that hundreds of his described forms are mere intermediate or temporary life-conditions. They are often found in large numbers—we may say, in myriads. They frequently hold very tenaciously to their intermediate forms, passing through a cycle or through cycles of existence ere they round out into the true, perfected plants.

With these facts, certainly known to our author, it seems hardly credible he should have wasted so much learning to uphold a chimera.

To us his efforts, in a previous number of the same journal, to uphold the unicellular algæ as stable forms, appear equally unreasonable; they are constant for a season, yet is their chief characteristic that of great changeability.

Dr. Cooke, of London, has commenced the publication of the "Fresh-water Algæ of Great Britain." The work appears in numbers. The plates are prepared with an eye to beauty, and the letter-press is made attractive; but it is to be regretted he does not give sufficient prominence to the instability and doubtful character of many of the forms already presented. Earlier authors have put forth much more advanced views.

One of the most masterly studies was made by the late Dr. H. Itzigsohn, of Russia. His essay on *Hapalosiphon Braunii* reveals a profundity of research into the life-history of a single plant, and displays the many forms which occur in its development. There is a similar history, perhaps, in many cases unwritten, belonging to many other forms.

Why should these be ignored, and the primitive notions be upheld with such tenacity? F. Wolle.

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Aquaria for Microscopists.

In the management of small aquaria a very little experience is of great value. The first attempts are usually not successful, but after a while it will be found that the aquaria run along without much trouble. The secret of this is in the experience, which seems to have come very naturally, that indicates to us just about how much plant-life should be in a given quantity of water, and where the aquarium should be placed to ensure the most satisfactory growth.

It need not be said that the conditions of prolific growth in an aquarium are the same as are found in open ponds, but to imitate those conditions indoors requires some judgment. The collector will observe that the water in ponds, although freely exposed to the glare of the sun, never becomes greatly heated, because of the rapid evaporation from the surface. But if an ordinary aquarium be thus exposed to the sun, the small body of water would soon become so warm that many organisms would die in it. Therefore, the aquarium should not be placed in sunlight. By far the best place is near a window where it can receive good light from the sky all day long, but no direct sunlight. The first, and most important rule is, keep the water cool.

For the microscopic specimens a small bottle, holding about 6 ounces, with square sides, makes an excellent aquarium. Such bottles should be about two-thirds filled with water, and covered to exclude dust. We have used the tin-foil that tobacco is wrapped in to cover them, and found it well adapted to the purpose. Several of these bottles should be kept with sprigs of water-plants growing in them, so that whenever an interesting specimen is found it can be put into one of them, to grow and multiply by itself. In this way it is sometimes possible to cultivate microscopic forms of life very successfully. We have thus grown hundreds of the common rotifers and kept them for weeks in the winter time. That was done, however, in a one-ounce bottle, which had a small bit of *Nitella* in it. We have also kept *Volvox* in fine condition for many days in a small bottle covered with a watch-glass.

Beginners in this work are apt to put too much material into their jars. A very small bit of a vigorously growing plant will suffice, and if too much is introduced, it will soon loose its vigor, and some of it will decay and make the water impure.

The jars should not be disturbed much, and when they are moved they should be handled carefully and then replaced as they stood before, in order to ensure uniform conditions of light and temperature.

We have seldom been troubled with an excessive growth of unicellular algæ on the sides of our jars. Usually these come from an excess of light. But a filamentous *Cladophora* found its way into one of our larger jars more than a year ago, and it became such a nuisance that finally the jar was given over to that plant entirely, and is now green with it. When the jar is wanted for other use it must be washed in boiling water to get rid of the too prolific alga. When minute algæ do come in such abundance as to be troublesome, set the jar in a dark closet for a few days and they will disappear.

However, for microscopic purposes such growths are not usually objectionable, for some of the infusoria delight in them, and it is not necessary to keep the sides of the small bottles clear, as in the case of larger aquaria. Nevertheless, they should not be allowed to increase too much, for if they do they may suddenly fill the water with a cloud of swarm-spores, and bring about a decomposition which will kill everything therein. Such a condition of affairs, if threatened, can be prevented by removing the jar a short distance from the window, when growth will be less rapid.

It does not seem to be a matter of much consequence what plants are used in the microscopist's aquaria. *Nitella* is a clean and hardy plant, and we have usually preferred it. One or two stems, a couple of inches long, is enough. *Anacharis* is also excellent for the purpose; *Myriophyllum* would doubtless prove quite as good, and perhaps even better, for it is a plant with leaves well adapted as a resting place for the tube-bearing rotifers. Besides these we have *Ceratophyllum*, *Callitrichia*, *Utricularia*, *Naias*, and *Potamogeton*, and some persons prefer *Ceratophyllum* above all other plants for the aquarium.*

As for the stocking of small aquaria, the only precautions are, not to put in too much material and not to put in animalcules that will kill each other. Our plan is as follows: When we have a collection of pond-life, plants and animals of all kinds all together, we put the whole mass into a saucer of water and let it remain there until it is convenient to look it over. In a saucer the collection will keep fresh while in a bottle it would soon become foul. Then, in looking over it with the microscope, the animalcules that it is desired to keep are transferred to the bottles, either

* As many collectors may not be able to distinguish these plants, we purpose to give illustrations of some of them as soon as the cuts are ready.—ED.

by washing them off from the slide upon which they are found, or if practicable, by the use of a dipping tube. But a mass of algæ or of debris that is supposed to contain infusoria of interest is not introduced at random. Such a mass may be dropped in for a few hours and then removed by forceps or dipping-tube; but it must not remain long enough to decompose. This should never be done in a bottle that already has a variety of living forms in healthy growth, as thereby there is danger of losing them by introducing incompatible creatures.

Sometimes it is desirable to keep a certain specimen found in a jar attached to something as a leaf or stem, separate from the others for a short time. This can readily be done by placing it in a small tube, uncorked, which can be suspended in the jar by means of a thread. In the same way a number of specimens can be selected and placed in tubes which can then be suspended in a jar of water and carried about—to a meeting of a society for example—in this way securing the advantages of a considerable quantity of water, while the specimens are easily found.

The secret of success is in having the plants in the small jars growing well before the infusoria are introduced. Even then many of them will not live, for they are very sensitive creatures and will not bear well sudden changes in their conditions of life. But perseverance and experience will bring their reward in this as in other things.

The microscopist who desires an inexhaustable source of entertainment, or a rich field for investigation during the winter evenings, can provide for these in no better way than by starting a number of aquaria now. September is the proper time to start aquaria for the winter, and we trust many of our readers will act upon the suggestions of this article, for if they will do so we are sure to hear of many observations they will make.

Besides the numerous small aquaria the microscopist would do well to have one or two large tanks, holding one or two gallons, in which can be kept a stock of plants and animals of different kinds, and one tall jar in which *Vallisneria* can be grown. In the large tanks should be kept different water-plants such as *Nitella*, *Anacharis*, *Myriophyllum*, *Lemna* (duck-weed), and others, from which the small aquaria can be replenished. In these may also be kept many microscopic specimens from collections, and especially snails and *Daphnia*, *Cyclops* and other entomostraca. The snails may be occasionally introduced into the small jars as scavengers, and the entomostraca can be used to feed the hydras, which will probably be found in one or more of the jars.

The cyclosis in plant-cells is very beautifully shown in *Vallisneria*, and this plant can be grown in a tall jar without any care whatever. The roots should be imbedded in mud and sand at the bottom. The plant will grow rapidly and probably fruit in the jar. It will die down in the fall, but in the spring, it will again grow if the roots are undisturbed.

Naias Flexilis and Cyclosis.

BY A. C. PALMER.

On a recent visit to Fresh Pond, Cambridge, about four miles east of Boston, Mass., I made careful search for some of the few and rare submerged grasses, or weeds, usually mentioned by microscopists, and in books on microscopy, as best disclosing the very interesting phenomenon of the cyclosis, or rotation of fluid in the cells of living plants. Of the plants, the *Anacharis alsinastrum* and the *Valliisneria spiralis* being most prominent.

I succeeded in finding the *Anacharis alsinastrum* in abundance, and of a beautiful deep-green color, in full, healthy growth.

I found also a submerged weed that I had never seen before, and not

mentioned, as far as I know, in connection with the cyclosis. This weed grows 6 to 12 inches in length, has flat, narrow leaves, somewhat crowded into whorls. It is called by botanists the *Naias flexilis*, and classed by Dr. Gray,* in the family Naiadaceæ genus *Naias*. This *Naias flexilis* discloses, under my microscope, the finest cyclosis phenomenon I have ever seen. I have mentioned this fact to a distinguished botanist, and to several eminent professors and microscopists, each of whom was unaware of its revealment of the clyclosis, and I therefore infer that others may be interested in this discovery.

On the outer side of the wooden pier, near the hotel, at Fresh Pond, there is a depth of ten or twelve feet of water, with a healthy growth of *Anacharis alsinastrum* on the bottom. On the left-hand, the water is eight or ten feet deep, and the bottom is literally covered with a fresh matting of *Naias flexilis*.

In a drop of water, place a small portion of the leaf of this plant on a microscope slide, with a thin glass cover—or better, use an animalcule cage. Let it remain quiet a few minutes, then view it with a mediuum eye-piece and a $\frac{1}{8}$-inch objective or higher power.

The bioplasm, and the chlorophyll or colored granules, will exhibit the cyclosis most beautifully, better it is believed, than has hitherto been ob-observed in any other plant.

The *Naias flexilis* is a perishable plant and if preserved in a glass jar for microscopic use, should be kept in a cool place, should have a plenty of room in the jar, and a free supply of fresh water.

[Mr. Balen informs us that he fully agrees with Mr. Palmer as to the beauty of the cyclosis in the plant mentioned above. We have also seen it, and can confirm all that has been said concerning it.—Ed.]

*Gray's "Botany of the Northern United States," page 482.

A Note on Cupelopagis.

Dr. Joseph Leidy has courteously called my attention to some descriptive remarks of his, reported in the "Proceedings of the Philadelphia Academy of Natural Sciences," Vol. ix., p. 204, "relating to an animacule found attached to stones in the Delaware and Schuylkill rivers * * * * closely allied in structure to the wheel animacules, yet possessing no rotatory or other ciliated apparatus." This rotifer (which he names *Dictyophora vorax*) is evidently closely allied to the one described and figured by me in the last number of this Journal, and probably belongs to the same genus. It is impossible to tell whether the species is also the same without a more detailed description, or a comparison of specimens.

Dr. Leidy's generic name is, however, preoccupied in entomology, having been used by Germar as early as 1833, for a genus of Hemiptera, and even before him for a fungus; and that proposed by me, will therefore have to stand.

The word "pushed" in line 8, p. 102, second column, should read "pursued," and the length of the body should be given as 0.016, instead of 0.16.

S. A. Forbes.

Normal, Ill., June 21, 1882.

Thin Glass Cells.

The Editor is not mistaken in saying (in reference to the article on p. 101), that Dr. Beale has described a somewhat similar method of making glass cells. Prof. Quekett, in the 3d edition of his "Treatise on the Microscope" (1855) says: "Dr. Beale recommends the following plan:—'One of the thick glass rings, fig. 214, is heated on the brass plate, and one side covered with marine glue. As soon as the glue is melted, a small piece of thin glass is carefully applied * * * when cold, a semi-circular, or round file is sharply thrust through the centre, etc.'"

Some ten or more years ago, I described, in *Science Gossip*, a modification of Dr. Beale's plan. It was somewhat as follows: Take a brass plate 3 in. × 1 in., and ½ an inch in thickness, place it carefully on the turntable, and with a "broach," or angle of a broken triangular file, make a circle of the diameter required, then drill it out and remove the burr; heat the brass slide and smear the margin of the aperture with shellac; place the thin glass circle in position, the diameter of which need not exceed that of the perforation by more than ⅛ of an inch; when cold, place the brass slide on the turn-table, and with a writing diamond inscribe a circle on the thin glass of the same diameter as the hole; make some scratches upon it, give a few taps with a file or pen-holder and the central portion of the disk will come away, leaving a cell with clean edges. Heat the brass slide hot enough to readily detach the cell; while the brass is still hot smear again with lac, and cement another disk to it. With ten or a dozen brass plates over a hundred cells can be made in two hours.

The cells are easily freed from the lac by placing them in alcohol. An ordinary glass slide may be perforated in a similar way. Place it on the turn-table, make a circle upon it with a cutting diamond, cement it (with lac) at right angles to the brass plate, and after scratching or cutting the centre with the diamond, the central portion may be knocked out with a file, or better still, with a little steel pointed hammer. Perforated slides are useful for mounting foraminifera, small insects, etc., a glass cover attached to the slide with shellac or marine glue forming the bottom of the cell, another forming the top, the upper and under surfaces being equally available for inspection. For dry-mounting of diatoms, and objects not much exceeding $\frac{1}{50}$ of an inch in thickness, I have for the last twelve months, been using cells prepared in the following manner: Wash some whitening in water to get rid of the coarser parts (foraminifera, spongespicules, etc.), or levigated chalk as sold by druggists can be used, and make a mixture about the consistency of cream with weak gum water; three or more applications will make cells of a sufficient depth; when dry go over them two or three times with a solution of Canada balsam dissolved in benzine; the cells should not be used until the balsam is quite hard; then place the cover (upon which the diatoms ought to be mounted) in position, and with a heated slide press it upon the cell, when perfectly attached the cement ring can be made in the usual manner.

FRED. KITTON,
NORWICH, Eng. Hon'y F. R. M. S.

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Sphagnum, Desmids, Rhizopods and Eels.

A recent visit to a pond in the southern part of New Jersey, primarily in search of rhizopods, proved so successful in other respects that it seems worthy of note. Attached to sticks, and floating objects in the water, were great clusters of the beautiful alga *Batrachospermum moniliforme*, and an abundance of *Chantransia macrospora* in every direction, even growing luxuriantly upon the thallus of *Batrachospermum*. But it was the bog-moss (*Sphagnum*) that contained the greater variety of microscopical treasures. Following Dr. Leidy's directions for collecting rhizopods, the water was squeezed from the submerged moss, the result showing what an abundance of living creatures a handful of sphagnum may yield to those interested in microscopical studies. Among the rhizopods, the most notable forms were *Difflugia spiralis*, *Placocista spinosa*, *Heleopera petricola*, *Hyalosphenia papilio*, *Sphenoderia lenta*, *Nebela caudata*, *Nebela ansata*, while among the algæ, the desmids were present in profusion. The following is but a partial list: *Cosmarium cucumis*, *C.*

cucubito, C. margaritiferum, Desmidium Swartzii, Didymoprium Grevillii, Hyalotheca disiliens, Staurastrum macrocerum, Xanthidium armatum, Closterium rostratum, C. Leibleinii, C. Dianæ, C. striolatum, C. setaceum, Tetmemorus Brebissonii, Micrasterias truncata, M. arcuata, M. furcata, M. denticulata, M. radiosa (*M. oscitans ?*) (*M. quadrata ?*), *Pleurotœnium baculum, Sphærozosma serratum, S. pulchrum, Spirotœnia condensata, Triploceras verticillatum,* and several species of *Euastrum.*

Infusoria were not absent. Probably the most noteworthy were *Rhipidodendron splendidum* and *Spongomonas intestinalis* which were abundant,while *Spongomonas discus* was not infrequent, and since the vessel has been standing on my table many large colonies of the curious *Spongomonas sacculus*, discovered in England by W. Saville Kent, have appeared and made themselves at home.

The shallow water below the floodgates to this Jersey mill-pond was literally alive with young eels from three to four inches in length. An occurrence which had never before come to my notice was that they were swarming out of the water and up one of the gate-posts. The wet, perpendicular surface of the wood, for a foot above the water, was covered by a writhing mass of eels, and when one fell back two seemed ready to take the place. What could have been the probable cause of the aerial gymnastics of these aquatic creatures?

A. C. Stokes.

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The Preparation of Diatoms.

Dr. R. S. Warren complains that directions for the preparation of diatoms are rather meagre in books. On perusing his article, I do not find that he has added anything new to our previous knowledge. In *Science Gossip*, 1877, pp. 145 and 217, he will find that all, or nearly all, his methods are fully described. Filtered water may be used in the preliminary washings, but before and after using sulphuric acid the material must be well washed with distilled water, in order to get rid of any lime that may be present, otherwise minute crystals of sulphate of lime attach themselves to the diatoms to their great disfigurement. His plan for eliminating sand is identically the same as given by me in the above named work. Whilst calling attention to my papers in *Science Gossip*, I do not claim to be the inventor of the plans therein proposed, many of them were suggestions of correspondents. The use of liquor potassæ was suggested some five and thirty years ago, by Professor Bailey. Liquor ammoniæ by Dr. Arnott, of Glasgow, but the plan of placing a drop of the sandy diatom material on a glass slide, as described in my paper, was, I think, new.

Query—What diatomaceous deposits are sub plutonic?

Fred. Kitton, Hon'y f. r. m. s.
Norwich, Eng.

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Staining and Preservation of Tube-casts.

To stain and preserve tube-casts, I have found a logwood staining solution, better than any other. This solution is made by adding 5 grammes of the extract of logwood, and the same quantity of alum, to 100 c. c. of water. The extract and alum should be thoroughly triturated before the water is added, and the whole then left to stand until the extract is completely taken up by the water, which requires several hours, and then filtered. The best course to pursue in staining, is to shake the bottle containing the urine, then pour it into a conical flask; after several hours, when the deposit is complete, either draw or pour off the supernatant fluid, and add to the deposit about an equal quantity of the staining fluid. At the end of one or two days, the casts will be stained a beautiful reddish-purple. I have casts prepared in this manner over

nine months since, and, though left in the tube in which they were stained, they are in every particular as perfect as at the time they were prepared. After staining, the casts can be mounted in balsam or dammar without undergoing any change.

A. T. PARKER.

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Cabinet for Slides.

BY J. H. PILLSBURY.

I have used the following with a great deal of convenience :—

In order that I might arrange my slides systematically, they must all lie flat to accommodate those which would be injured in any other position. I had neat trays with sawed slots for twenty-five slides in each tray, arranged on end in a case, with a lid about two inches deep to allow the trays to project far enough to be taken out easily when the lid is open. Each case holds twenty trays in two rows, accommodating five hundred slides. Labels for the names of the slides are stuck on the upper ends of the trays, and the slides may be numbered and lettered to correspond with letters on the trays, and numbers on the slots if desired. When the lid is open I have a classified list of the five hundred slides before me for instant reference.

SPRINGFIELD, Mass.

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Significant Angle.

In the April number of this JOURNAL, appeared a paper on Telescopic Field and Microscopic Aperture.

The author of that paper, the Hon. J. D. Cox, thinks the angle usually called the angle of aperture of microscopic objectives should give place to an entirely different angle, measured by a method which he clearly describes. Of this proposed angle he says, on page 64 : "If there be any significant angle in optics, it would seem to be this, and it would seem also to be the true angle of aperture of the lens, if the term has any definite meaning." Devotees of microscopy will naturally examine pretty carefully any angle which is thus offered as a substitute for the present one, however willing to adopt any improvement.

The precise difference between the accepted angle of aperture and the one under examination is this: the former is bounded by rays which proceed from a point of the object, situated on the principal axis, and pass through opposite margins of the objective to a conjugate point of the image; the latter is bounded by rays proceeding from a point between the object and the lens, passing through opposite margins of the lens to opposite margins of the field-glass of an ocular.

The angles under consideration are $l\,o\,l'$ and $l\,o''\,l'$ of fig. 24, page 63, to which figure the reader is referred.

Inspection of that diagram will enable any one to see that $l\,o\,l'$ is "significant" to the extent that it gives the angular breadth of the cone of rays which the lens is capable of transmitting—theoretically at least—from a point of the object to a conjugate point of the image; and that the variation of the angle, as the distance of the object from the lens is changed, corresponds to the variation of the efficiency of the lens used with different lengths of tube. Indeed, if the angle and the tube-length with which it was measured be given, it is easy to say in advance what will be the performance of the lens with any tube-length; and the eye-piece employed is a matter of indifference except as to the question of magnifying power and amount of image visible.

The angle $l\,o\,l'$ is "significant," again, because it, supplemented by the focal length, enables us to determine the effective linear aperture of the lens, which gives it special claim to be called the angle of aperture.

Moreover, since the vertex is always situated in the object, $l\,o\,l'$ is usually regarded as the "angle of aperture" for all applications of the

lens, telescopic or microscopic. Let us see what significance attaches to the proposed substitute *l o'' l'*. It certainly does not give us, when supplemented by the tube-length used in measuring it, the angular breadth of the cone of rays transmitted from object-point to image-point, nor any capability of the lens dependent on that item, unless the linear aperture of the field-glass is specified in addition. Even then considerable calculation is needed to ascertain the very points easily obtainable from *l o l'*. Additional complication arises from the fact that *l o'' l'* increases or diminishes as the tube is shortened, accordingly as the linear aperture of the field-glass is greater or less than that of the objective. But the implication that the so-called telescopic angle *l o l'* and the so-called microscopic angle *l o'' l'* are constructed on a similar principle, or by a similar method, is the most surprising feature of Mr. Cox's paper.

The image *c' d'* from which *l o l'* is derived, is said to be "bounded by the marginal rays of the cone *l o' l'*.

Of course, the portion of an image at *c' d'* which is visible to an eye at *o'* is so bounded, but there is no special significance in that fact, except that the partial image taken as the "telescopic image" varies with the size of the lens, though the whole image does not.

If the visible portion viz., *c' d'* of the whole image furnishes a basis for *l o l'*, then an angle intended to be analogous to *l o l'* should be based upon the partial image analogous to the portion *c' d'*. Such analogous portion of the image formed at *a' b'* must be smaller than the visible portion of that at *c' d'*, because the eye would be moved backward as far from *o'*, as *o'* is from *c' d'*. Although it is stated in the paper that "in both cases the examination of the image may be made by a properly constructed eye-piece, or by the naked eye" it seems to have been overlooked that both images should be viewed by an eye-piece, or by the eye, not one image by the eye and the other by the eye-piece. In the case given in the paper, fixing the image at *a' b'* by looking at it from a point back of *o'* would make *a' b'* shorter than *c' d'*, while its length, determined by an eye-piece, is greater—as the figure shows. Whatever, then, may be the practical difficulty in determining the hitherto accepted angle of aperture, it does not appear that anything is to be gained by substituting for it any such angle as the one proposed.

F. C. VAN DYCK.

EDITORIAL.

Subscriptions.—Remittances for subscriptions should be made by post-office or express money-orders, by draft payable in New York, or in registered letters. Money sent in any other way will be at the sender's risk. A receipt will be immediately given for money received by open mail.

The JOURNAL is issued on the 15th day of each month. Subscribers who do not receive their copies at the usual time are requested to inform the Publisher of the fact.

EXPRESS MONEY-ORDERS.—The American Express Company has established a system of money-orders, which, we believe, will become very popular with those who have occasion to remit money in small sums, as soon as its advantages become known.

The rates are: for $1.00 to $5.00, five cents; over $5.00 to $10.00, eight cents. Subscribers to this JOURNAL can, therefore, send the price of subscription with absolute safety for five cents. In all cases we advise money to be sent in accordance with the suggestions at the head of this column.

While referring to remittances we take occasion to say that it would be a great accommodation to us if correspondents in small towns would procure drafts on banks in this city, instead of sending checks on local banks.

——o——

UNIFORMITY IN OCULARS.—Among the subjects of importance to be brought before the meeting of the American Society of Microscopists at

Elmira, is that pertaining to the size and nomenclature of eye-pieces. Looked at from a purely business point of view, we are sure that, however desirable it may be to secure uniformity in size and nomenclature, and however strongly the advantages may be presented by the Committee having that matter in charge, no action the Society can take will alone bring about the desired uniformity. Manufacturers of microscopes, with perhaps two or three exceptions, will not change their machinery at the dictates of any Society. The only way to secure uniformity is to convince purchasers of its importance. Nevertheless, this is no argument to discourage the Society from adopting a standard of uniformity, for the result can only be brought about by some initiatory action from some influential body. We look for the report of the Committee with great interest.

——o——

TABLE OF NUMERICAL APERTURE.—Last month we printed a table of numerical aperture, and a micrometric table, but as it is not always convenient to refer to the JOURNAL to examine the table, we reprint them this month on one of the advertising pages, so that they may be torn out for use.

It may be that some readers do not fully understand the aperture table. We do not consider it advisable to explain it in detail, for the subject of numerical aperture has already been discussed quite freely in these columns; but if there is anything still obscure about the meaning of the table, or concerning the relation between angular and numerical aperture, we will endeavor to make it clear to anyone who will plainly state the difficulty.

It will be convenient to remember a very simple relation between the metric and the English micrometric measures, which is expressed as follows:—

.001 cm. = .00039370 inch.
$\frac{1}{2500}$ inch = .00040000 inch.

The difference between these is, .00000630, an amount quite unworthy of consideration for ordinary micrometric purposes, so we may say that

.001 cm. $\frac{1}{2500}$ = or .0005 of an inch.

——o——

PRESERVATION OF PROTOZOA.—A thoroughly good method of preserving minute organisms would be of great value to microscopists. The process of A. Certes, by means of osmic acid, is effectual in many cases, but not always satisfactory.

Eugen Korschelt,* describes the following method, which he regards as better than that of Certes: A very small drop of water containing the infusoria is placed on the slide and covered with the thin glass. A 1 per cent. solution of osmic acid is then allowed to flow under the cover, and drawn off at the opposite side. It is followed by water, and then by 70 per cent. and 90 per cent. alcohol, and finally by water. For coloring the now fixed and hardened animals, C. Weigert's picro-carmine is used. It is allowed to act 1½–2 hours, when it is removed and again 70 per cent. and 90 per cent. alcohol are used, followed by absolute alcohol, oil of cloves and Canada balsam.

This process, the author states, can be carried out in a short time, and gives fine results with many infusoria. But for some, the amœbæ for example, the osmic acid will not do. For amœbæ therefore, a 2 per cent. solution of chromic acid is used instead, the other manipulations being the same as for osmic acid. The chromic acid should act 2–3 minutes.

In this way many infusoria and flagellates have been preserved without the slightest shrivelling; the cilia and vacuoles remain as in life, and the granules and nuclei are colored intensely red. By far the most surprising result is obtained with the amœbæ; their form is fixed and the vacuoles are to be seen even in the

* *Zoologischer Anzeiger*, 1882, No. 109.

finest pseudopodia. Heliozoa are also perfectly preserved in this way.

Bernard Landsberg* objects to the above process because all the operations are performed under the cover-glass, which renders it impossible to remove dirt, etc. He recommends the following ingenious method which requires no great operative skill, as even beginners in microscopy readily succeed with it. The water is examined on a slide, or in a watch-glass, under the microscope. When an animal is found that one desires to preserve, a capillary tube is brought near it, under the microscope, and as the water runs up the tube it carries the animal with it. It is blown out of the tube into a drop of 1 per cent. osmic acid solution, upon another slide. After about ten minutes (at the longest) it is stained with picro-carmine, or with Beale's carmine, washed wih water, and alcohol is added, followed by oil of cloves. The object can be transferred to another slide by means of the capillary tube.

Still simpler is the process for minute, rapidly swimming protozoa. When they are collected in a watch-glass with a small quantity of water, the necessary quantity of osmic acid is added, then successively the coloring matter, alcohol, and oil of cloves; all this is done in the watch-glass. The animals remain so fixed in mucous that seldom one is lost by drawing off the fluids.

Canada balsam is not so good for many infusoria as glycerin; *Actinosphærium Eichornii* is much better shown in glycerin. The foamy appearance of the ectosarc is distinctly revealed by this method of preparation, and the contractile vacuoles remain as in life.

Will some of our readers try these processes and send us a report of their results? Chromic acid can be purchased of druggists, and if osmic acid cannot be obtained, we will gladly purchase it for any subscriber who may desire it.

* *Zool. Anzeiger*, 1882, No. 114.

Impurities in Ice.—There is great difference in people! Some are most excellent fishermen and others are not. Now, we have no doubt that Mr. Balen, who has furnished many of our readers with microscopic organisms in great variety, is a good fisherman in his way. But even he must yield the palm to a medical gentleman who has been catching the microscopic animals and plants and "morphological impurities" of ice. We refer to Dr. Ephraim Cutter, of New York, "Member Philosophical Society, Great Britain, etc., etc.," who has written upon this subject, and whose article and illustrations speak for themselves in the columns of the *Scientific American* of July 29th. Indeed, Dr. Cutter has found the ice so rich in microscopic organisms of widely different kinds, that we most unhesitatingly recommend our readers whenever they want to make an exhibition of microscopic life for their friends to obtain a few pounds of ice, melt it and put the sediment under the microscope.

The article in question begins with a "Prelude," in which we are informed that the subject is "interesting because ice is an article of commerce and is extensively consumed." Some of the hard words are explained, but invariably it is stated that the "filtrate" is examined microscopically, when in fact it is not the filtrate at all but the matter left in the filter that contains the impurities—yet, we doubt not, almost as much might be found in the filtrate by an equally successful observer.

We will not attempt to name the hundreds of things that contaminate the ice—the only thing conspicuously absent seems to be the "ague plant." There are bacteria, which he suggests may be the "babies (as it were) of vegetation." The *Astrionella* is accredited with a power of "self-symmetrical arrangement." As regards "dirt," it is "hard to picture," and as for many other things found in the ice, the author is not sure they are hurt-

ful, but he thinks "water is more potable without them." We suppose that is particularly the case with what he calls "epithelia."

And the article occupies more than two pages of the *Scientific American!*

NOTES.

—A new microscopical journal has been established in England, *The Journal of the Postal Microscopical Society.* It is to be published Quarterly, and is to contain extracts from the note-books, original articles, and microscopical news from various sources. The first number was issued in March, and contains fifty-six pages of reading matter and five plates. Among the articles, one by the Hon. J. G. P. Vereker, on Numerical Aperture, is about the clearest elementary explanation of the subject we have yet seen; a translated article by Dr. L. Dippell, On The Microscopical Examination of Chlorophyll, Inulin and Protein-crystals is interesting to botanists. Mr. A. Hammond, describes the curious worm *Tubifer rivulorum*, with the aid of a plate. In each number, selections from the notes of Mr. Tuffen West will be given.

We would be greatly pleased if our own Postal Microscopical Society were sufficiently active to publish a quarterly magazine of equal excellence, from the notes which are sent around the circuits.

Since the above was written, the second number of the *Journal* has come to hand. It is fully equal to the first one, and contains several good articles; among them one on "Spiders, their Structure and Habits," by William Horner, which is very readable.

—In the last catalogue of Mr. Gundlach's objectives, issued by Mr. Sexton, a $\frac{1}{100}$-inch is advertised, and Mr. Sexton informs us that such an objective is to be made. We hope to live long enough to see it. Will it be any worse than the $\frac{1}{75}$-inch which Mr. Tolles made a few years ago?

—A good method of drawing from the microscope without a camera-lucida is to have a glass disk in the ocular ruled in squares. The paper upon which the drawing is to be made should be also ruled in squares. The outlines of the object can be readily traced upon the paper and the different parts correctly located in the drawing. Mr. W. T. Suffolk, who has used this method, recommends that the rulings in the ocular should be about $\frac{1}{20}$ of an inch apart.

—It is with regret that we occasionally find the columns of our most valued exchanges encumbered with laudatory words for pretentious scientific observers, whose only claim to public recognition is the notoriety which they have secured through a not very discriminating press. Such articles impress us more and more with the opinion that the truly meritorious, the most pains-taking, and conscientious, and thoroughly scientific work, is the last to be recognized by the press and the public. Perhaps this is because the true scientific investigator is satisfied to present the results of years of labor in an unostentatious and quiet manner, while the more superfical worker is quick to foist upon the public his premature conclusions, and always ready to make them as sensational as possible. Yet we have papers that pretend to be scientific, which should not be led astray in such matters. Why should the labor of a man like Dr. Koch be placed upon a level with the vagaries of another observer who has found and described a specific bacterium for almost every species of disease the flesh is heir to?

This is the position virtually assigned to him by an article in one of our most influential exchanges, and it must be discouraging to the true student of science to find so little appreciation of the work of the man of science, and such laudation of the less deserving,

CORRESPONDENCE.

TO THE EDITOR:—I think I am doing a service to users of the microscope, especially to those who intend to carry microscopes with them on their journeyings this summer, by bringing to their notice a new stand made by Schrauer of this city, which "packs well." It has a base similar to that on the instrument which was known as the working model of George Wale, except that the base is made of solid brass, instead iron. Moreover, there are no parts of sheet-brass. By unscrewing the binding screw, this base can be removed, and, together with the rest of the stand, also taken apart, and laid between other goods in one trunk, thus taking up far less space and travelling more securely than the ordinary stand which tumbles about in a huge square case occupying almost half of the trunk.

It is also an excellent stand to take to Microscopical Society meetings for it may be put into a small hand-bag, which can be carried much more easily and comfortably than the square box usually carried. In addition to its good qualities as a traveller, the specimen of this stand which I have possesses other excellencies. It is heavy, firm, with a low, solid stage, a tripod foot, a short tube capable of elongation, adjustments of extreme accuracy and smoothness, the coarse by rack and pinion, the fine by a long sensitive lever, and it cost only twenty five dollars.

W. H. M.

MICROSCOPICAL SOCIETIES

At a meeting of the CAMDEN SOCIETY, on May 4th, Mr. J. Carbutt, exhibited his apparatus for dry-plate photography, using his lantern specially arranged for that purpose. A good feature of his apparatus is the use of rubber balls beneath the base-board to prevent vibration.

The IRON CITY MICROSCOPICAL CLUB, is a new association which has started with fair prospects of a prosperous future. The President is Dr. T. J. Gallaher, and the Corresponding Secretary is Prof. J. H. Logan, 198 Penn Avenue, Pittsburg. An interesting meeting was held on the evening of June 5th, at which Dr. R. C. Jillson. read an article upon diatoms, after which a number of objects, and instruments were exhibited.

A regular meeting of the CENTRAL NEW YORK MICROSCOPICAL CLUB was held in Syracuse, Tuesday evening April 25th, when a number of interesting objects were exhibited, including one showing the heart's action, and capillary circulation of blood in a young trout, by Dr. Clifford Mercer; the palate and teeth of a snail, and a beatifully stained section of the *Symplocarpus fœtidus*, showing the cellular and glandular structure of the plant, by Dr. Chas. E. Slocum.

In the order of business and discussion, great gratification was expressed by the members at the success which attended the soirée, held April 14th and 15th, at the Keble School buildings, where there were eighty or more microscopes, with their varied and excellent exhibits.

The regular meeting of the WELLESLEY COLLEGE SOCIETY, was held March 25th, the President in the chair. After the reading of the minutes the evening was devoted to a variety of subjects; chiefly to reports upon the character and contents of the various journals of science and microscopy, which are placed upon the library table every month.

The regular meeting for April 29th, postponed to May 6th, was held with the President in the chair. After the reading of the minutes a paper on Insectivorous Plants was read by Miss Clarke; this was very fully illustrated by elaborate blackboard drawings and by living specimens. This was followed by a report by Miss Adgate, upon the most interesting articles in the various journals of microscopy for the current month. Miss Emerson then read a paper on Polarized Light. After this, Professor Whiting gave an exhibition of thin rock-sections by polarized light with the lantern. After the transaction of business, the Society adjourned to the laboratory, where a number of objects were exhibited.

A Microscopical Society has recently been reorganized in Cleveland, O., with the following named officers: Dr. W. B. Rezner, President; Dr. C. B. Parker, Vice-President; C. M. Vorce, Esq., Secretary; and Dr. Robert Dayton, Treasurer. Meetings are to be held on the first and third Tuesdays of each month.

A meeting was held June 20th.

Dr. C. B. Parker, gave an instructive address on the sealing of glycerin mounts.

Dr. Robert Dayton, read an interesting paper on the method of producing brilliant crystals of copper, exhibiting a collection of very fine slides of these objects.

Dr. Allen Y. Moore, addressed the Society on the subject of Blood, describing, and practically illustrating, his method of double-staining and mounting blood-corpuscles.

The discussion regarding the subjects named brought out many interesting facts, and exhibited a very active interest on the part of the members of the Society.

A Microscopical Section has been formed by members of the BRIDGEPORT SCIENTIFIC SOCIETY, having already sixteen active members.

NOTICES OF BOOKS.

Photography with Emulsions: A Treatise on the Theory and Practical Working of Gelatine and Collodion Emulsion Processes. By Captain W. De W. Abney, R. E., F. R. S. New York: Sco-

vill Manufacturing Co., 1882. (Pp. 248. Price, $1.00.)

Captain Abney is one of the most eminent authorities on photography; and he has done much experimental work of great scientific value. Thoroughly versed in the chemistry of photography, and practically familiar with the details of the art, no one is more competent to write a book on emulsion photography.

The work before us is written for practical photographers, who, as a class, are not chemists or scientific men. Hence the author has endeavored to describe the various processes of preparing emulsions in language intelligible to all. We have been surprised, in reading this book, to find so little theory in it. Its great value lies in the numerous recipes for emulsions and developers, given so plainly, and with such care that the merest tyro ought to have no difficulty in preparing them.

The processes of developing plates prepared by different methods are given, and the action of the various developing solutions is explained. We cannot give a lengthy notice of this book, since it is hardly within our province; but for all who wish to learn something of the theory of photography, as well as how to prepare dry-plates, we know of no better work. It is a useful book of reference for those who are interested in photography as amateurs, either in field-work or in connection with the microscope.

The Student's Manual of Histology for the use of Students, Practitioners and Microscopists. Second Edition. By Chas. H. Stowell, M. D., Asssistant Professor of Histology and Microscopy, and the Instructor in the Histological Laboratory of the University of Michigan. Illustrated by one hundred and ninety-two engravings. Detroit: Geo. E. Davis, 1882. (Pp. 190. Price, $2.00.)

The first edition of this book was published last year, and was favorably noticed in this JOURNAL on page 180 of Volume II. The new edition only differs from the first, so far as we can perceive, in having some typographical errors corrected, and we can only reiterate our opinions, more fully expressed last year, of the practical value of the book to the student of histology. The information contained in it is concise, and carefully selected to meet the wants of a large class of students. We take pleasure in once more commmending the work to our readers.

The Domain of Physiology or Nature in Thought and Language. By T. Sterry Hunt, LL.D., F. R. S. Presented to the National Academy of Sciences and read before it in Abstract, April, 1881. Published in the London, Edinburgh and Dublin Philosophical Magazine for October, 1881, [V,] XII, 233—253. Second and Revised Edition. Boston: S. E. Cassino, 1882. (Pamphlet, pp. 28.)

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Wanted, material containing Pleurosigma angulatum, Nitzschia sigmoidia, Frustulia Saxonica and Amphipleura pellucida. Mounted diatoms or material in exchange.

T. CHRISTIAN,
108 Virginia, St., Richmond, Va.

Rubber cement of my own manufacture, in exchange for good slides.

EUGENE PINCKNEY,
Dixon, Ill.

Well-mounted sections of Rat's tongue, Rabbit's eye and Cat's muscle for other well-mounted objects.

F. B. CARTER,
519 Gates Ave., Brooklyn, N. Y.

On receipt of a well-mounted slide, I will send a slide of crystal, (for the polarizer) of any of the rare vegetable products which I may have; will send list of same on receipt of postal request.

J. KETCHUM, Jr.,
P. O. Box 877, New York City.

Wanted. — Animal parasites, Ixodes, Acari, etc., either mounted or unmounted. W. A. HYSLOP,
22 Palmerston Place, Edinburg, Scotland.

Unmounted objects, Foraminifera, Spicules, Plant-hairs, Zoophytes, etc., in exchange for other objects, mounted or unmounted.

E. PINCKNEY, Dixon, Ill.

Wanted—First-class mounts of double-stained vegetable preparations in exchange for first-class insect preparations. H. S. WOODMAN,
P. O. Box 87, Brooklyn, E. D., N. Y.

Wanted—First-class prepared and crude material, or mounted objects, in exchange for diatoms *in situ* or other first-class crude material, or for mounted objects.

M. A. BOOTH, Longmeadow, Mass.

Wanted—Good gatherings of Diatoms, fossil or recent, especially of test forms. Liberal exchange in fine slides; prepared or rough material. Lists exchanged.
C. L. PETICOLAS, 635 8th Street, Richmond, Va.

Good, uncleaned Diatomaceous material containing *Arachnoidiscus*, *Heliopelta*, *Pleurosigma*, *Isthmia*, *Triceratium*, *Surirella gemma* and *Terpsinoë musica* wanted, in exchange for well-mounted slides of arranged diatoms, etc., or cash.

DANIEL G. FORT, Oswego, N. Y.

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American Association for the Advancement of Science.

SECTION OF HISTOLOGY AND MICROSCOPY.

The meeting of the American Association for the advancement of Science was held this year at Montreal. It began on the 23d of August and continued one week. About one thousand members attended the meeting, and some of the papers read were of great scientific value.

In the section of histology and microscopy, as well as in some of the other sections, papers were presented on subjects of interest to microscopists. In the following report of the meeting, notices and abstracts of the papers read pertaining to microscopy will be found.

Prof. Wm. H. Brewer read a paper before the section of physics, entitled

APPARENT SIZE OF MAGNIFIED OBJECTS,

in which he gave the results of a long series of experiments on the apparent size of the image formed in the microscope, as seen by different persons. About 440 different persons were questioned as to the size of the images of various objects, but finally a small insect was selected as the test-object. The actual length of the image, as drawn by the camera lucida, using a 1½-inch objective, was 4.66 inches, including the antennæ, 4.87; the diameter of the field was 5.85 inches.

The results may be briefly summed up as follows: Of the 440 persons, about 41, or 9 per cent., judged the size quite correctly; 82 of them, or 19 per cent., made the size 4.25 to 5 inches, which was reasonably good. The greater number of persons underestimated the size; 2 estimated it at less than one inch, 7 made it over a foot, 45 made it 2 inches, or less, 22 made it 10 inches. The largest estimate was by a mechanic, who said it looked like a picture projected on a screen and it seemed to be five feet long. Experience seems to correct false estimates, as was illustrated by three estimates by a gentleman who used the microscope in drawing; in three successive years his estimates were respectively 9, 8 and 7 inches. The subject was briefly discussed, and Mr. LeConte Stevens made a few remarks upon the physiological aspect of the matter, which will be given next month.

Dr. B. W. Carpenter, of London, being present at the meeting, was requested to address the section of microscopy. A large audience assembled on Friday afternoon to hear the views of the eminent microscopist upon the subject of the best objectives for biological work. He spoke without notes, and the report given below is believed to be as full and as accurate a summary of his remarks as could be obtained without the aid of a stenographer's report.

DR. B. W. CARPENTER'S ADDRESS.

This address was quite popular in character—well-adapted to the audience assembled, which included many persons not familiar with the microscope. The speaker said he would attempt to give the results of what has been going on in Europe and America—both practical and theo-

retical results—in the history of the microscope. He referred to the investigations of Prof. Abbe, as having led to a knowledge of the principles of microscopical optics. In the line of delicate investigation Messrs. Dallinger and Drysdale have watched the growth and development of objects so inconceivably minute as to have been heretofore regarded as invisible. They have observed flagella of a diameter one-tenth the breadth of an absolutely immeasurable line.

American microscopists, he said, are now going over the track which the English passed over twenty or twenty-five years ago, and have now abandoned. As we are going now, they went and found no valuable results to biological research. He had lived through the whole period of achromatic microscopy in England. About 1828–9, when nothing was known there of what had been done in France, or by Amici, Goring stimulated Tulley to make an achromatic lens of ½-inch focus. I saw that and was very much impressed by it. In London I bought a French combination of Chevalier, and ever since I have had a microscope—for over fifty years. The first advantage recognized in the use of achromatic lenses was that the angular aperture could be increased. With a single lens a stop or diaphragm had to be used, cutting off the marginal rays, but it was soon found that with an achromatic lens the whole face of the lens could be used, and thus more light and finer definition were obtained. At first the scales of the blue *Menelaus* were used as the finest test; then, when a quarter-inch was produced, we began to see parallel, wavy markings on the podura scales, which was then regarded as a great feat. After that came the definition of the markings, as we see them at the present time. I still hold the podura scale as the best test of an objective for biological research.

For a long time there was a rivalry between Ross, Powell & Lealand and James Smith as to which should make the widest angular apertures. As these were increased the diatom-tests came into use. Sollitt discovered some diatoms which he used as test-objects, and it was soon found that resolution depended upon angular aperture and less upon defining power. The biologists still held to the podura scale test—they said a lens should not only resolve diatoms but also define podura. The podura should not be neglected. But the manufacturers did not take the same view of the subject, and they continued to make lenses to resolve diatoms. The introduction of diatom-tests was, however, exceedingly valuable. But, besides definition, focal depth is required. I have seen it stated in some American and French publications that any penetration in a lens is a great fault. I hold that a lens which does not possess that quality is inferior.

Within the last few years we have come to understand many things. Prof. Abbe has shown that resolution is not effected in the manner heretofore supposed—that diffraction spectra take part in resolution. Now we understand why angular aperture is valuable. Prof. Abbe has come to the same conclusions I have advocated for thirty years—that it is impossible to have focal depth and very wide angular aperture. Increased angle has given great power of resolution; but what else? Nothing at all. Angle can only be obtained by lessening working distance. The result is, we see nothing but what is in the focal plane. It is well and serviceable to apply such lenses to verify a thing you have already worked out. Drs. Dallinger and Drysdale used a power of 4,000 diameters, and watched the swelling out and growth of mere unmeasurable particles. This is high biological work, and Mr. Dallinger assures me that it could not be done without penetrating power. Mr. Dallinger is perfectly sensible of the value of different kinds of objectives

for purposes of verification. He has a battery of lenses of narrow and wide angles. The best lenses have as large an angle as is compatible with requisite focal depth.

One point I wish to impress upon American microscopists. It has been claimed that low powers of high angle are equal to higher powers; that a $\frac{4}{10}$ with wide angle will do everything. It will resolve tests, but its continued use will injure the eyes. I never perceived any injury to my eyes, notwithstanding that J. Edwards Smith said that my eyes were failing because I could not see the difference between wide and narrow angles. Dr. Dallinger believes if he had worked with a $\frac{1}{8}$ instead of a $\frac{1}{25}$ he would have injured his eyes. I remember the first $\frac{4}{10}$ by R. Beck. It was a good glass. To work up a $\frac{4}{10}$ to 150° destroys its value. I hear of Americans making one-inch objectives up to great angles, for which the society-screw is too small. This makes a very bad $\frac{1}{4}$ and spoils it for a one-inch. This conclusion is in entire conformity with the mathematical results of Abbe. I have only stated the conclusions we have generally come to on the other side. High-power eye-pieces are valuable for testing objectives. A good two-inch should resolve the podura scale, with sufficient magnification from the eye-piece. For £10 or £12 a good set of English objectives up to a $\frac{1}{12}$-inch can be obtained, which is about the cost of a single $\frac{4}{10}$ by an American maker.

In reply to a question of Dr. Tuttle, Dr. Carpenter stated that the $\frac{1}{25}$ used by Dr. Drysdale was a dry lens of 140°.

Prof. Burrill asked if Dr. Carpenter intended to say that a high-angle lens of high power was only good for the resolution of lines. In reply, it was stated that the flagella of *Monas termo* would probably not have been found without the wide-angle lens, but now they are known to exist, they have been seen better with a lower angle.

In illustration of his position, Dr. Carpenter also referred to some observations with low powers of wide and narrow angles used with the binocular, and instanced the structure of the diatom *Isthmia* as revealed by a Zeiss' ¼ of 40° with the binocular. In speaking of the advantages of binocular microscopes, he mentioned as a very beautiful object, a transparent injection of brain, which, when once seen with a low angle and binocular, would never be looked at in any other way.

He also mentioned a trial of two ½-inch objectives, by different makers, of 90°, which he desired to use for the study of *Polycystina*. The perspective was so greatly exaggerated that they could not be used. He procured stops which respectively reduced the angle to 60° and 40°. With the full aperture of 90° the object appeared like the small end of an egg, with the stop of 60° it appeared like the large end of an egg, with the stop of 40° the perspective was true. A ½-inch of 40° was then ordered of Powell & Lealand, who were at first unwilling to make such a low-angle glass, but finally did so, and at a soirée of the Microscopical Society it was exhibited beside the 90° lens, and the difference between them was so striking as to attract universal attention and commendation of the low-angle lens.

Dr. William Osler read a short article on

MICROCYTES OF THE BLOOD

and their probable origin. In brief he said: Microcytes are exceedingly minute, red blood-corpuscles about $\frac{1}{3000}$ of an inch in diameter, which are met with in the blood of embryos and of the new-born, occasionally in small numbers in the blood of healthy individuals, in certain diseases, particularly the severer forms of anæmia, and after hemorrhage. No satisfactory explanation has been given of their origin. The author has seen their production in the spleen-

tissue and in the bone-marrow by a sort of budding from the ordinary red blood-corpuscles. In the conditions above mentioned, particularly after hemorrhages and in profound anæmia, the red corpuscles often present great irregularities in outline. In fresh specimens of spleen and bone-marrow the author has seen these little particles become detached from the blood-cells moving about in the currents on the slide, and when so detached presenting all the characters and appearances of the microcytes.

Papers were also read by Dr. Osler on "The Third Corpuscular Element in the Blood," and "The Development of Blood-corpuscles in the Bone-marrow;" and one by Prof. William Libbey on "A New Form of Constant Injection Apparatus." We regret not to have abstracts of these papers, which, although very short, were valuable.

Dr. Osler also read a valuable paper entitled

DEMONSTRATION OF THE BACILLUS OF TUBERCULOSIS.

This paper was illustrated by two slides—one of the bacillus of tubercle stained and mounted, the other the bacillus of anthrax, also stained, shown for purposes of comparison. The difference in size between the two forms was striking.

The process of demonstration described, was substantially as follows: The substance to be examined, after drying on the cover-glass in the usual manner, is first treated with caustic potash. The bacilli are then visible, but to render them more distinct, and to distinguish them from any other forms that may be present, the cover is flowed with a solution of anilin violet, which stains all the other bacilli, but leaves the organism in question quite colorless. The preparation shown was not made by this process, for in it the bacilli were stained.

Dr. Louis Elsberg, of New York, read a paper entitled

PLANT-"CELLS" AND LIVING MATTER.

This article was merely a continuation of a series of contributions which have been emanating from a few gentlemen in New York City, during several years, of which no notice has heretofore been taken in these columns for the reason that the Editor has not wished to assist in the dissemination of speculations, which, he is convinced, are based upon erroneous interpretations of facts even if the observations themselves should prove to be correct. However, now that the subject has been brought up and discussed before the section of the Association, it demands at least a passing notice here. Throwing aside, for the present, the account of some observations on plant-structure which the author described, and which only the want of suitable notes prevents us from giving in detail, we pass to the essential feature of the paper, which was the exposition of the "bioplasson theory." The bioplasson theory is opposed to the theory of cells. All living matter—bioplasson—is supposed to be made up of reticulations of living substance with inert matter filling the reticulum. It is said that the reticulum can be easily demonstrated by microscopic observation—that one has only to look for it and it will be found—that it exists in the white blood-corpuscle, and in the amœba, and can be seen in them without the use of reagents. In the paper referred to the author assumed this to be true, and nothing in the paper would lead one to doubt that it was a doctrine universally upheld by biologists. But after the paper was read, and some complimentary words had been spoken for the author, the Editor of this JOURNAL, arose and protested against the general acceptance of views so radically at variance with previous knowledge and observation, until they have been thoroughly examined. He called in question the very existence

of the net-work, and declared that it could not be seen under the circumstances mentioned. Dr. Carl Seiler, while not declaring against the doctrine advanced, desired to be informed just how the net-work could be found. He had looked for it, but never seen it. His questions were met by evasive, or very general, replies, until they were put in such form as required direct answers to the specific points. The result of the whole discussion was that Dr. Elsberg declared the net-work to be easily seen, while others, who had looked for it, doubted its existence.

We feel disposed to regard one course of argument followed by the author of the paper, as quite unbecoming in a gathering of scientific gentlemen. In fact, it may justly be regarded as decidedly impertinent to come provided with a number of standard and elementary works on botany, and assuming, if not, indeed, declaring, that those who are at variance with him are ignorant of the contents of those works, challenge them to look and see what he has described confirmed by drawings by observers of unquestioned ability and skill. Properly enough, the insult was unnoticed, although fully recognized.

Realizing full well that an attempt on our part to present the merits of this subject at length, might not be entirely satisfactory to the supporters of the "bioplasson" doctrine, we offer them the free use of these columns for a fair presentation of the doctrine before the microscopists of the country, if they deem it desirable, with the understanding that the subject be treated as concisely as possible, so as not to occupy too much space.

Dr. Henry C. Marcy spoke on the "Histology of Uterine Fibroid Tumors" which he illustrated with photo-micrographs.

Prof. T. J. Burrill then presented his paper on "Some Vegetable Poisons," an abstract of which will be printed next month.

A most valuable and interesting paper was read by Prof. W. A. Rogers, which will doubtless be published in full in the *Journal* of the Royal Microscopical Society. The following abstract covers most of the ground of the original paper :—

In offering a communication upon the subject of ruling fine lines on glass I am not unmindful of the fact that I am entering a field in which I acknowledge a master. Since the death of Nobert, Mr. Fasoldt, of Albany, stands first in the art of fine ruling. I have confined my attention to an attempt to subdivide any given unit into sensibly equal parts. I have been led to take up the subject of fine rulings anew, by the claim of Mr. Fasoldt, that he has succeeded in ruling lines one million to the inch, and especially by his claim that the spectrum of such bands, is an evidence of the reality of the separate lines. * * * * * * * * * *

When a diamond is ground to a knife-edge, this edge is composed of separate crystals, and a perfect line is only obtained when the ruling is done with a single crystal. When a single crystal does all the work, the line ruled is densely black. It is not a simple scratch—an abrasion of the surface. A portion of the glass surface is probably always removed to a greater or less extent. In many cases the glass is thrown up as a plough turns up a furrow. Sometimes the surface is covered with filaments thrown off by the diamond, which are removed by rubbing the surface, at other times the filaments take a spiral form. In a certain condition of the diamond-point, the lines ruled appear black and clear along one edge, but by rubbing, the glass, which seems to have been turned up in a furrow, is removed, and then the lines appear as mere scratches.

To rule lines finer than 10,000 or 20,000 to the inch, requires a diamond-point that has been used a

long time—until it has acquired a knife-edge parallel with the line of motion, in which only a single crystal does the cutting. For fine lines the point improves by use. * * * *

If Mr. Fasoldt's claim is reduced by about one half, I am by no means sure, but it may be realized. But what evidence have we that it is possible to see lines of this degree of fineness?

In the matter of limit of resolution, it must be admitted that little or no progress has been made since the resolution of Nobert's 19th band. * * * I cannot learn that any one has yet succeeded in photographing a Fasoldt plate as high as 100,000 to the inch. With due respect for the honest belief of several microscopists who claim to have resolved Fasoldt's bands as high as 152,000 to the inch, I yet hold to the opinion that in no case has the resolution been proven. There is only one test which is absolutely decisive—that of ruling a definite number of lines in a band, and keeping the number secret until the microscopist can give the correct count, not merely in one instance, but in several. * * * The apparent number of lines in coarse bands can be varied. Can any one offer a reason why there should not be a similar variation in fine bands? In certain cases there is no certainty that the lines are actually cut in the glass. There is often an appearance of perfect lines, but they disappear when the surface is rubbed. Mr. Hitchcock, in a recent number of his Journal, has made the claim that resolution has, to a certain extent, ceased to be a test of the quality of an objective. I presume this claim will be found to have some foundation in fact. For the last ten years we have only the assertion of resolution, but not the proof. It is time the proof should accompany the assertion. I insist that the simple vision does not afford the required proof. * * * Before we can safely assert that observation has gone beyond theory, we must be prepared to offer evidence which can be placed upon record, discussed, and impartially weighed. * * * Let us have a test which will forever set at rest this vexed question of resolution. * * * Let Mr. Fasoldt rule three plates, under as nearly the same conditions as possible except in the number of lines in the different bands of each plate. Let him label each plate, and accompany it with a full description of the number of lines in each band. Let these plates be sent to any gentleman in whom the great body of microscopists have confidence as eminently qualified to conduct an investigation of this kind. Let whoever receives the plates remove the labels of Mr. Fasoldt, and put in their place labels whose significance is known only to him. Then let those gentlemen who think they have resolved 152,000 lines to the inch make their count of the lines in each band, and send in their reports. Let the plates also be photographed and let the number of lines be counted. Then let the results of these investigations be published. If all substantially agree in the count, this will end discussion.

The paper concluded with an account of some experiments with very fine single lines. Lines too fine to be seen singly with the microscope can be resolved if ruled close together in bands. Single lines estimated to be $\frac{1}{50,000}$ of an inch are readily seen by the naked eye, and even lines $\frac{1}{180,000}$ of an inch in width can be seen without a microscope. A plate was shown with the coarser lines ruled upon it, and which were easily seen by every one who tried to find them.

The following is an abstract of a paper read by Dr. Thomas Taylor:—

THE HOUSE-FLY AS A CARRIER OF CONTAGION.

About eighteen months ago, while dissecting the head of a common house-fly, I observed a very minute, snake-like animal, a species of anguil-

lula, moving out of the posterior end of its proboscis, which was ruptured. It measured about eight one-hundredths of an inch in length by two one-thousandths of an inch in diameter. Subsequently I determined to ascertain the interior dimensions of the suction-tube, or proboscis, of the house-fly, for the purpose of comparing it with the diameter of this parasite. Placing a fly which I had asphyxiated with naphthaline on a glass slide, and securing it on its back by means of thick gum, I was able to measure the parts and observe all the movements of its proboscis, and found its suction-tube to be of sufficient diameter to admit of taking up the spores of cryptogams, trichinæ, the eggs of anguillula, or even the anguillulæ themselves.

Noticing a violent commotion in the abdomen of the fly thus operated on, I became convinced that one or more of the anguillulæ were present in the abdomen, and were the cause of the unusual movements observed. On removing the head of the fly, a lively anguillula was seen moving out from one of the ruptured ends of the œsophagus. The animal was quickly secured, and placed under a glass cover in a drop of water, where it exhibited very lively eel-like or snake-like motions. Shortly a second appeared, when all commotion in the abdomen ceased.

Of the genus anguillula there are upwards of one hundred known species. * * * The species I have found in the house-fly exhibits different internal structures, in some respects, from any others that I have yet examined. * * *

The facts above stated suggested to my mind the importance of instituting a series of experiments to ascertain whether house-flies might not be carriers and distributers of germinal virus. I have found in the proboscis of a single house-fly thirteen of the animals already mentioned in a perfectly developed condition, and on the thorax of another I have found sixteen living parasites of the genus acarus. * * *

To test practically the question whether flies may become the carriers of contagious germs, I instituted a series of experiments. In a glass receiver having a capacity of about five gallons of air, I placed several hundred house-flies which had been caught in an ordinary fly-trap. Within the receiver was placed a quantity of the spores of the red rust of grasses (*Tricholoma*). The flies at first did not seem to esteem the spores as suitable food, but on the morning of the third day I found that the rust was replaced by larvæ and remains of eggs of the common house-fly.

The eggs were deposited and hatched between Saturday noon and the following Monday morning, 9 o'clock, or in about forty-eight hours. On the following day I placed in the receiver about a quarter of an ounce of the same description of spores combined with sugar. The flies partook of this confection, consuming the sugar and most of the spores. In about twenty-four hours after the flies had partaken of this mixture I killed and dissected a number of them, and found the small intestines intensely colored, of a deep reddish orange shade, representing the digested spores of tricholoma. I observed in the contents a few well-defined orange spores, but none of them appeared to have germinated. Fastened between the hairs on the limbs of each of the flies examined I found a number of the spores, and the efforts of the fly to get rid of them only resulted in attaching them more firmly to it. They might, however, be brushed off by objects with which they were brought in contact, while their germinating powers would long outlast the life of the insect itself. It was evident from this experiment that flies were capable of conveying such spores to plants and other bodies. On the other hand, the fact that by far the greater part of the spores were

consumed, in the one case by the larvæ of the fly and in the other (*i. e.*, when mixed with sugar), by the fly itself, shows that this insect may destroy microscopic germs as well as disseminate them, and indicates that in some cases its agency in keeping down their number may more than counterbalance its action in contributing to their dissemination.

Dr. Thomas Taylor, exhibited and described his improved freezing microtome, and exhibited the instrument in operation. It is figured in the accompanying illustration, and briefly described as follows :—

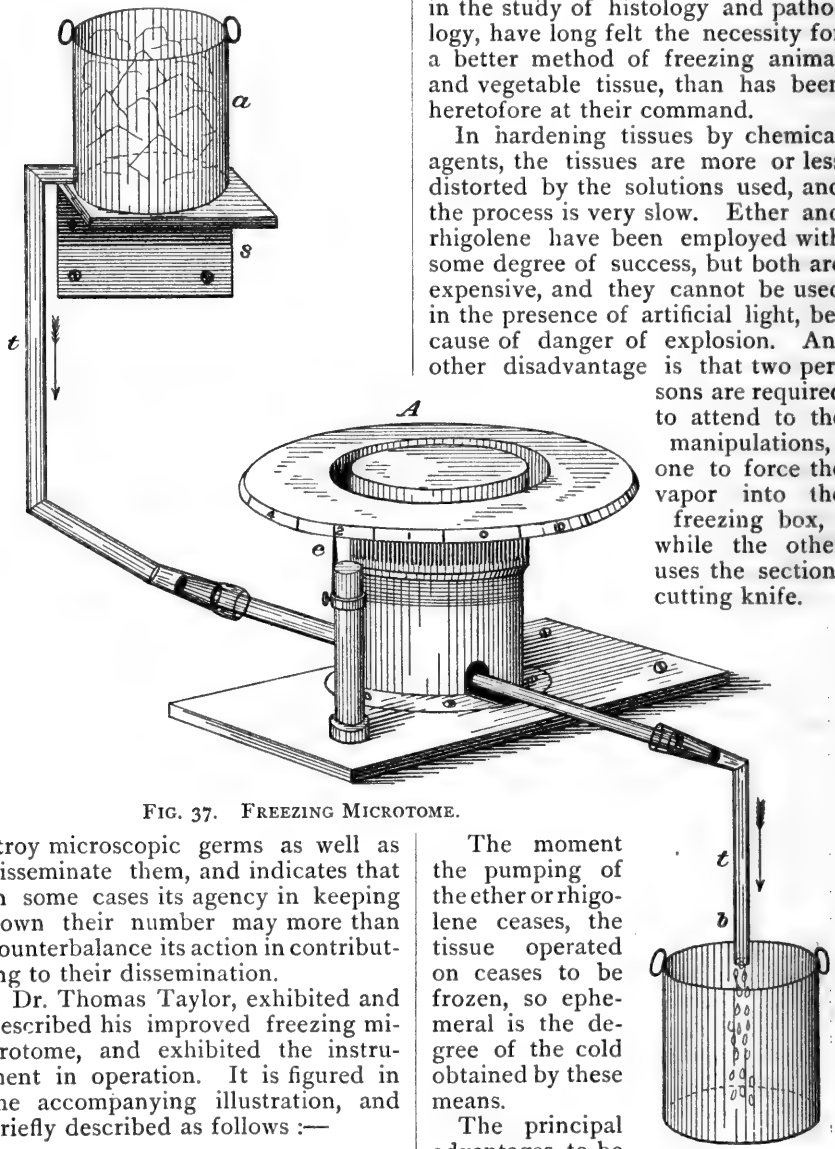

FIG. 37. FREEZING MICROTOME.

TAYLOR'S FREEZING MICROTOME.

This microtome presents all the advantages of any plan heretofore employed in hardening animal or vegetable tissues for section cutting, while it has many advantages over all other devices employed for the same purpose.

Microscopists who are interested in the study of histology and pathology, have long felt the necessity for a better method of freezing animal and vegetable tissue, than has been heretofore at their command.

In hardening tissues by chemical agents, the tissues are more or less distorted by the solutions used, and the process is very slow. Ether and rhigolene have been employed with some degree of success, but both are expensive, and they cannot be used in the presence of artificial light, because of danger of explosion. Another disadvantage is that two persons are required to attend to the manipulations, one to force the vapor into the freezing box, while the other uses the section-cutting knife.

The moment the pumping of the ether or rhigolene ceases, the tissue operated on ceases to be frozen, so ephemeral is the degree of the cold obtained by these means.

The principal advantages to be obtained by the use of this microtome are, 1st, great economy in the method of freezing, and, 2d, celerity and certainty of freezing. With an ex-

penditure of twenty-five cents, the tissues to be operated on, can be kept frozen for several hours at a time. Small objects immersed in gum solutions, are frozen and in condition for cutting, in less than one minute.

The method of using this microtome can be understood by reference to the illustration. *A* represents a revolving plane, by which the thickness of the section is regulated, in the centre of which an insulated chamber is secured for freezing the tissue. It resembles a pill-box constructed of metal. A brass tube enters it on each side. The larger one is the supply tube, and communicates with the pail *a*, situated on bracket *s*, by means of the upper tube *t*. To the smaller brass tube is attached the rubber tube *t b*, which discharges the cold salt water, into a pail placed under it. (See *b*.) The salt and water, as it passes from pail *a* to pail *b*, is at a temperature of about zero. The water should not be allowed to waste. It should be returned to the first pail for continual use, or as long as it has freezing properties. As a matter of further economy, it is necessary to limit the rate of exit of the freezing water. This is regulated by nipping the discharge-tube with the spring clothes-pin supplied for the purpose. Should the cold within the chamber be too intense, the edge of the knife is liable to be turned and the cutting will be imperfect. When this occurs the flow of water through the chamber is stopped by using the spring clothes-pin as a clip on the upper tube. In order to regulate the thickness of the tissue to be cut a scale is engraved on the edge of the revolving plate *A*, which, in conjunction with the pointer *e*, indicates the thickness of the section.

Prof. D. P. Penhallow read a paper "On Some Peculiarities Incident to the Diseases of Fruits," of which we have no abstract. The paper treated mainly of the results of chemical analysis.

Mr. C. E. Hanaman described a "Filtering Wash-bottle Especially Adapted to the Use of the Histologist." It is intended to hold the reagents and staining fluids in common use. It consists of a Wolfe's bottle with tubes arranged as in a chemist's wash-bottle, so that when air is forced into one tube the fluid is forced out of the other. The first tube is provided with a rubber pressure-bulb for compressing the air; the second supports a filtering tube filled with cotton, so that the reagent is always obtained free from suspended particles.

Mr. J. H. Pillsbury read a very interesting article, which was a portion of a more comprehensive paper, "On the Development of Cilia in the Planula of *Clava leptostyla*." We hope to print this contribution in a future number, but it requires illustrations which cannot be prepared in time for this issue.

Prof. W. H. Seaman, read a paper of which the following is an abstract prepared by the author :—

A FUNGUS ON THE LEAVES OF PEAR TREES.

In 1865 and 1876 my attention was directed to numerous small, black dots with which the leaves of pear trees in the vicinity of Washington were covered. A slight examination showed me that the fungus (for such the dots proved to be), was as yet undescribed in the books, and I immediately endeavored to ascertain if it had been previously seen by observers. After some correspondence, I found that the Rev. J. L. Zabriskie, of New Baltimore, New York, had specimens of similar character, collected by Rev. R. G. Strong, in 1873, on the leaves of quince. Mr. Zabriskie published a short description of his specimens on little slips of paper, which he distributed to a few friends, and which so far as I know, is the only printed notice of this pest. The slip is as follows :—

Blastesis, new genus.—Perithecia

concealed, with central orifice. Spores compound, oozing in a minute pustule.

Blastesis tridens, new species.—Spots scattered, circular, black, pierced by the oozing mass of spores; spores unisiptate, fiddle-shaped, hyaline, the upper one furnished with a long, straight or flexuous seta, a pair of smaller cells budding out, one from either side of the deep constriction of the septum, each also furnished with a long seta; nuclei large; pedicels fugacious, short or wanting. Autumn.

The above generic description does not distinguish the genus from many others of similar character. The fungus on the pear usually appears as soon as the leaves are fully developed, on the upper side exclusively, and sometimes exhausts the leaf so that it drops off and dies, and in one case caused the death of an Arbre courbe tree by repeated defoliation. Usually, however, it seems to disappear about July, and is not again seen during the season.

The Montreal Microscopical Club extended an invitation to the section of Histology and Microscopy to attend a meeting of the Club at the building of the Natural History Society, on Monday evening, August 28th. The members of the Club proposed to give "a practical demonstration of various modes of illumination." Several pieces of home-made apparatus were exhibited by Mr. Miller, among them a spot-lens with a movable stop, and a Kelner eye-piece arranged with a revolving diaphragm for use as a condenser. Dr. Baker, the Secretary, made some demonstrations to show the value of ground glass to modify the light on certain objects. Dr. George Wilkins, of Bishop's college, exhibited a fine lot of Zeiss' microscopes and accessories, and a form of freezing microtome which had given him excellent results.

Dr. B. W. Carpenter was invited to address the meeting, and he spoke for some time on the subject of microscopes, and then gave an account of studies on the *Eozoon canadense*, after which he exhibited some fine specimens of that structure, under microscopes.

Mr. L. R. Sexton was present with some of Mr. Gundlach's latest work, but, unfortunately, most of the time he was too ill to exhibit it. We had the pleasure of meeting there Mr. Carl Lomb, who had with him a fine lot of apparatus from the Bausch & Lomb Optical Co. We were greatly pleased with the new large stand of those makers, and intend to illustrate it soon in these columns.

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The American Society of Microscopists.

The fifth annual meeting of this Society was convened at Elmira, N. Y., on the 15th day of August, 1882. At half-past two o'clock Dr. S. O. Gleason, the President of the Elmira Society, opened the proceedings by an informal address of welcome to the members assembled. Dr. George E. Blackham, the President of the American Society of Microscopists, replied to this address, and, after declaring the meeting duly opened, he presented his annual report, as President. We make the following abstracts from the report:—

THE PRESIDENT'S REPORT.

* * * * * * * * * * *

"When I was honored by election to the presidency of this Society at Columbus, O., last August, it was quite apparent that a crisis had been reached which demanded prompt and energetic action, and justified some departures from conventional methods.

"My first official act was to call a meeting of the Executive Committee at the house of the Secretary, Professor Kellicott, in Buffalo; the next was to issue a circular to members, giving a list of the newly-elected officers and their addresses, and offering some suggestions as to preparations for the present meeting. I pre-

pared a circular and question-blank to makers and dealers in microscopes which, with the approval of the Committee on eye-pieces, was printed and sent out by the Secretary. Several additional meetings of the Executive Committee have been held, and by means of various circulars in addition to the above, sent out either by the Committee or myself personally, and a somewhat extended correspondence, I have managed to keep myself in constant communication with our widely scattered membership, as well as with a number of working microscopists not yet affiliated with us. * * * The Committee on eye-pieces, having fully considered the matter, determined first to get together as much information as possible, and with that end in view, took action as already stated, requesting that replies be sent to Dr. R. H. Ward, its Chairman, to whose very competent hands the preparation of the report has been entrusted.

"It has been found to be quite impossible to deal finally with this subject at the present time, but the report of progress will, we believe, prove interesting and suggestive, and show the advisability of continuing the Committee for another year. * * *

"The prize offered by Mr. E. H. Griffith, for the best paper on the adulteration of some important article of food or medicine and its detection by means of the microscope, having been formally accepted by the Society, a circular was issued by order of the Executive Committee, giving information as to terms of competition, etc. Another valuable prize was offered by Prof. Stowell, editor of *The Microscope*, but after consultation with members of the Executive Committee, I felt obliged to decline it, for the reason, among others, that there was not sufficient time to get the matter properly before the members, and allow of a satisfactory preparation of papers. I recommend that this whole subject of prizes be taken up, and that the fixed policy of the Society in regard thereto be decided upon and announced. It will require careful consideration, as there is much to be said both for and against the practice."

At the conclusion of the report the regular order of business was taken up. New members were elected, and the reading of papers was begun. In giving the brief notice of abstracts of the papers read it should be stated that they are founded upon the reports published in the newspapers of Elmira, many of which are quite erroneous; but until the Society recognizes the disadvantage of withholding from publication all papers read before it until they appear in the *Proceedings*, after a lapse of six or nine months, we do not see how we can give perfectly satisfactory accounts of the meetings to our readers. Nevertheless, we will endeavor to do justice to all concerned with such information as is available, and in the course of a short time the difficulties now in the way will surely be removed.

Prof. D. S. Kellicott read the first paper—on "Certain Crustaceous Parasites of Fresh-water Fishes." Of this we have no account. Dr. Redding presented a contribution treating of the use of osmic acid for staining and hardening. Mr. C. M. Vorce spoke of the organisms observed in the water of lake Erie—a subject which, as our readers well know, Mr. Vorce has been studying for several years. In the evening President Blackham delivered his address. The subject was: "The Evolution of the Modern Microscope." The following abstracts are taken from the Address:—

"The earliest employment of the microscope as an instrument of scientific research, though traced back definitely to the latter part of the sixteenth or the beginning of the seventeenth centuries, cannot now be assigned with any degree of certainty to any one individual or country, even. * * * Zacharias Jansen & Son, of Amsterdam, are said to have manufactured them as early as

1590, and it is believed to have been one of their instruments that he brought with him to England. It was an imposing affair; a copper tube six feet long containing the lenses; and was mounted upon three brass dolphins, which rested upon a base of ebony. * * * In 1856, Dr. Robert Hooke, of London, published his famous work entitled 'Micrographia Illustrata,' in which he describes and illustrates an immense number of objects, as seen through the imperfect instruments of his day; and he describes a method of constructing lenses of great magnifying power in the form of tiny globules of glass. He also seems to have been the first to avail himself of the principle of immersion. * * * But the honor of being the first really scientific microscopist should no doubt be accorded to Antony Van Lewenhoek, whose numerous highly important discoveries were all made with the most primitive instruments, constructed by himself, consisting (not of spheres or globules), but for the first time of a double convex lens, provided with arrangements for holding the object and regulating its distance from the lens. * * * His labors in the field of human histology were also very great and fruitful, including as they did, investigations into the minute structure of the nerves, the discovery of the capillaries and the like, and when we consider the difficulties under which he labored, we may well be amazed at the extent and general accuracy of his discoveries. * * * Dr. Robert Hooke, however, was the first to use a compound microscope consisting of a simple objective, a simple eye-lens and an intermediate lens, which latter, however, was inserted only to enlarge the field of vision, not to increase its power. An Italian, Eustachio Divino, constructed an instrument whose tube was 'as large as a man's leg,' and with an eye-piece 'as broad as a man's hand,' consisting of two plano-convex lenses, somewhat after the manner of Ramsden's positive eye-piece, used sometimes at the present day for micrometric work. This microscope could be drawn out to four lengths, giving magnifying powers of 41, 90, 111 and 143 diameters respectively. A few years later a compatriot of his, Fillippo Bonani, first made use of rack and pinion for purposes of adjustment, and of a substage condenser for improving the illumination. During the following century improvements were constantly made in the construction and mounting of the simple microscopes; the most important, perhaps, being that of Nathaniel Lieberkuhn, of Berlin, who placed his object-lens in the centre of a highly polished concave speculum, by means of which a strongly concentrated illumination is reflected upon the upper side of the object. This method of illumination, as adapted to the modern compound microscopes, is still used with apparent satisfaction by some microscopists of the British school. Sir Isaac Newton, was the first to propose a reflecting microscope; but little seems to have come either of his, or of any of the numerous subsequent designs of this character. * * * * * * * * * * *

"Lieberkuhn also constructed the first solar microscope for projection of magnified objects upon large screens; and the same was equipped with the movable mirror, to admit of its protracted use by a Mr. Cuff, of London, where Lieberkuhn first exhibited his invention. But the high hopes engendered by it were never realized, partly, no doubt, on account of its dependence upon direct sunlight — always an uncertain factor especially in England — but more particularly because it can only display the shadow of things, instead of the objects themselves. It still survives, however, in a modified and improved form, as the oxy-hydro and electric light projection microscopes which, though valueless, for the pur-

poses of original investigation, are of great use for the demonstration of certain classes of objects, to large numbers at one time.

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"A certain Mr. Marshall appears to have constructed the first compound microscope, according to our modern conception of the term. * * * Yet as late as 1821, we find the great French philosopher, Biot, insisting that 'opticians regard the construction of a good achromatic microscope as impossible,' and at the same time Dr. Wollaston—the highest authority upon this subject then in England—gave it as his opinion 'that the compound microscope would never rival the single one,' * * * yet in less than two years thereafter two French opticians, Selignes and Chevalier, produced the *reductio ad absurdum* of all this *à priori* theorizing in the shape of compound achromatic objectives, consisting each of two or more pairs of lenses, each pair in turn, consisting of a double convex glass; and four years later Amici produced an achromatic combination, surpassing anything previously constructed in this line; and from that time on, the principle of combining two or more lenses, so shaped and adjusted as to correct each other's errors, was firmly established. * * * To the discoveries of Joseph Jackson Lister, and their practical application by working opticians, like Andrew Ross and Smith, of London, we owe the production of compound objectives of wide aperture, flatness of field, and above all, of highly perfected definition. * * * Then followed in rapid succession improvement upon improvement; the immersion principle was utilized (Amici and Hartnack); the aberration produced by the cover-glasses corrected (Ross); the angle of aperture increased to 135 degrees, which for a long time was held to be the largest attainable. Meanwhile, there had grown up, in a little village of this State, a young man of a scientific and practical turn of mind, who had taken up for himself, and by himself, the study of optics, and had even in his boyhood, made with his own hands, a microscope and some telescopes, and later on had done, though without much encouragement or patronage, good work as a microscopist too. Reading Ross' paper, and not feeling satisfied with his theoretical reasoning, he soon brought forth practical proof of the correctness of his own instincts by manufacturing a dry one-twelfth inch objection of 146° aperture. This young man was Charles A. Spencer. The lenses which were believed to have so nearly attained the limit of perfection, fifteen years ago (resolving Nobert's fifteenth band, *i. e.* lines 1-91,000th of an inch apart) are antiquated now, and the theoretical limit of perfection has thus moved forward and forward like the horizon, and seems destined ever to recede. Thus Surgeon General Woodward, of the navy, has since resolved the entire nineteenth band on the same plate."

We have felt obliged to omit a considerable portion of this address, partly for want of space, and partly because of a few minor errors of fact which have crept in, and which should be corrected before the address is published in full.

Mr. Henry Mills read a paper on the fresh-water sponges. He reviewed their classification by Carter, and referred to the labors of Prof. Kellicott, of Buffalo, and Mr. Potts, of Philadelphia, in connection with American sponges.

Mr. Ernst Gundlach presented a paper on "Light and Illumination," which seems to have stirred up quite a discussion between some of the members. Probably Dr. Gleason summed up the question in a manner satisfactory to all, when he stated it as follows: "Do we see what we see, or don't we see what we see, or do we see what we don't see?" It seems no one can tell in every case yet.

Dr. A. M. Bleile read a paper entitled "The Effects of Division of the Vagii upon the Heart," and Dr. M. L. Holbrook described the terminations of the nerves in the liver. His investigations fully upheld the views of Nesterowsky, that the nerves terminate in the capillaries. This paper led to some discussion, but mainly upon another subject, viz.: the so-called net-work structure of the blood-corpuscle, which was supported by Drs. Barrett and Holbrook, but not by the other members.

Dr. George C. Taylor exhibited a form of the Hitchcock lamp well adapted for microscopical use, and Mr. W. H. Walmsley read a short paper on micro-photography, and photographed the proboscis of a fly at the meeting.

Prof. H. L. Smith read a memoir of the late Charles A. Spencer, the opening paragraphs of which we quote :—

CHARLES A. SPENCER.

"Since our last meeting, one of our most distinguished associates, one who has been justly considered as the pioneer of scientific optics in this country, has been taken from us.

"Mr. Spencer was, in the truest acceptation of the word, a genius. Life was not to him a contest for the possession of what the world commonly calls gain. No man was ever more indifferent to this than he. From his boyhood he seems to have had an all-controlling idea, a self-consciousness, which seemed but conceit to those who did not understand him, or realize how much there really was in him, of his ability to produce better optical work than the world had yet seen. There is in existence a portrait of him, taken when he was but twelve years old, and which must have been a very truthful likeness of him, for it shows already the character of the future man. He is looking straight forward with a fearless eye, and already reading on the scroll of fame the name of Charles A. Spencer. The bright visions of his boyhood were realized, but he had little conception of what it was to cost him, and that the struggle was only to end with his life.

"Few of those who have in past years accomplished much in the way of perfecting instrumental means of scientific research, or the advancement of the economic arts, have, during their lifetime, received any adequate reward, and certainly Mr. Spencer was not an exception. He might have gathered a more abundant harvest of what the world terms wealth, if he had understood, and practiced somewhat closer, the ways of the world in financial matters; but where then were the brilliant results? Mr. Spencer was not only industrious, though not in a way for pecuniary recompense, he was also economical and of unblemished moral character; for we must not consider the unfulfilled promise—the often apparent and blamable neglect arose from no intention or design on his part to say, or do, aught wrong. He had an unbounded hope, it was a moral certainty to him, a faith in himself of being able to do all he had promised; and of accomplishing all he might undertake, which only lacked prudence in the ways of common life, and a closer watching of the balance-sheet, to have been fully justified. He has gone—he has left only friends. He had outlived most of those who hailed his advent as an honor to American science. And in the rapid march of improvement of the past decade, he had begun to feel, with his infirmities and declining powers, that he was almost left behind. We cannot say he had not grave faults, few of us but have; happy if, when we lie down to rest, so few will be remembered of us. When the name of many a successful man, as the world deems success, shall have been forgotten, and the marble on which alone it is recorded shall have crumbled away, that of Spencer will still live; nor will it be forgotten until the

human eye no longer needs a microscope, but shall see clearly the now hidden things of God.

"Mr. Spencer was born on Quality Hill, in the town of Lennox, N. Y., in the year 1813. He was the youngest son of General Ichabod S. Spencer and nephew of the late John A. Spencer, of Utica, N. Y. He came from Lennox to Canastota about 1831 and to Geneva in 1875, and died at the latter place September 28th, 1881, at the age of sixty-eight. Mr. Spencer was educated at the Cazenovia Academy, and after graduating there he entered the freshman class at Hobart, then Geneva College, at Geneva, N. Y.; his uncle, Dr. Thomas Spencer, being at that time a professor in the medical department of the college. He remained at Geneva, however, less than a year, and soon after went to Hamilton College, at Clinton, N. Y., of which his uncle, Judge Joshua A. Spencer, was then one of the trustees. His repugnance to being educated at the expense of others, or as a 'charity student,' as he termed it, was so great that he did not long remain at Hamilton, but returned to Canastota to study and experiment by himself, as he had found that, at that early day, comparatively little attention was paid in the colleges to the subjects which most interested him, most of the time being devoted to classical studies. He betook himself, therefore, to more earnest, practical work in science, not, however, neglecting to give a fair attention to classical literature, and in later years he received the honorary degree of A. M. from Hamilton College."

Mr. Thomas Taylor described his new freezing microtome. The Chairman of the Committee on eye-pieces, Dr. R. H. Ward, reported progress, by letter, stating that all manufacturers but one had agreed to designate their eye-pieces by their focal-lengths, but no agreement had yet been made as to the diameter of the tubes.

Mr. J. D. Hyatt read a paper on the influence of diatoms upon the odor and taste of drinking water, as demonstrated by observations on the Croton water. The substance of this paper has already been printed in these columns.

Dr. Robert Dayton described a modification of the half-button illuminator, devised by himself.

Prof. S. H. Gage read a valuable paper on the relations of fat-cells to connective tissue. The results of investigation are thus summarized:—

"1. With the use of the microscope as an instrument of research, it is unmistakably shown that the fat of the body is not free in the tissues, but in small circumscribed masses, which, with the development of the doctrine of the cellular structure of the animal body, were considered as cells.

"2. With the growth of the conception of the unity of life, the complex structure of man has been investigated through the lower animals, and adipose tissue is now recognized by all as composed of protoplasmic cells, simply holding their fat in readiness for the use of the body.

"3. This paper attempts to show that by the study of adipose tissue in a very simple form, the conflicting views as to the origin of the fat cells may be harmonized. And while its main thesis is that connective tissue-corpuscles may become fat cells; it also holds that the special or migratory cells of Ranvier and others may likewise serve as fat reservoirs, and finally our knowledge in its present state points unmistakably to the conclusion, that after a cell has given up its fat it reassumes in full its previous functions."

Mr. E. H. Griffith, who has been constantly improving his "Griffith Club Microscope" for the last two years, exhibited one of them and explained it in detail.

The officers elected for the next meeting are the following: President, Albert Mc Calla; Vice-presidents, E. H. Griffith, George C. Taylor;

Secretary, D. S. Kellicott; Treasurer, George E. Fell; Executive Committee, H. F. Atwood, L. M. Eastman, F. S. Newcomer.

Several dealers in microscopical goods were represented at the meeting. Mr. Edward Pennock had a large number of instruments from J. W. Queen & Co., including a set of Prof. Abbe's diffraction plates and diaphragms, to illustrate his theory of vision with the microscope; an Abbe test-plate for studying the correction of an objective; a mechanical finger devised by Prof. C. H. Kain, and various other articles of interest.

Messrs. Bausch & Lomb had a number of their excellent microscopes and objectives on exhibition, in charge of Mr. Edward Bausch. Mr. W. H. Walmsley exhibited a line of goods by R. & J. Beck, of London. Mr. L. R. Sexton had with him some of Mr. Gundlach's latest productions, but an attack of sickness prevented him from showing them.

—o—

A Simple Method of Determining the Angle of Aperture of Immersion Objectives.

For the determination of the angular aperture of objectives, if not less than 96° in crown-glass, I propose to attach to the front surface of the objective, by means of a "homogeneous" medium, in the usual way, a small piece of crown-glass, which has, besides the adhering surface, two other polished plane surfaces, at right angles to the former and parallel to each other, with a distance between them of at least the diameter of the front lens of the objective.

Then, from two distant points, lying in the plane described by the optical axis of the objective and the perpendicular upon this axis and the parallel plane surfaces of the glass piece, let rays of light fall upon these surfaces, to pass through the glass and then through the objective.

Find, in the usual manner, by moving the lights sideways, that direction of the two light rays by which the latter will just strike the outer edge of the aperture of the objective. Then determine the angle described by the two rays before entering the glass piece, and find the true crown-glass angle of the objective by calculation after this formula:—

$$\frac{cos.\ i}{r} = cos.\ a$$

i being half the angle of the two rays before entering the glass piece; r, the refractive index of the glass piece; a, half the crown-glass angle of the objective.

ERNST GUNDLACH.

EDITORIAL.

Subscriptions.—Remittances for subscriptions should be made by post-office or express money-orders, by draft payable in New York, or in registered letters. Money sent in any other way will be at the sender's risk. A receipt will be immediately given for money received by open mail.

The JOURNAL is issued on the 15th day of each month. Subscribers who do not receive their copies at the usual time are requested to inform the Publisher of the fact.

THE AUGUST MEETINGS.—We have given up the greater part of the JOURNAL this month to reports of the August scientific meetings, deeming it on the whole more satisfactory to print these reports while they are fresh and new, than to continue them through two numbers, as heretofore. The meeting at Elmira was, we are informed, a great success, and has doubtless given a great impetus to the Society. It has also shown that the main support of the Society is from the West. All the officers elected are Western men, and it has been stated that only one member from east of the Hudson River was present at the meeting. The Society should not fail to recognize how much is due to the efforts of a few gentlemen in the Elmira Society for the success of this meeting.

It must be a cause of sincere regret to those members of the Society who are aware of the facts in the case, that one gentleman who was

eminently deserving of the President's position, and whose personal efforts and influence for the Society made it peculiarly proper that he should have been placed in that position, was regarded as ineligible because a few of his colleagues considered that he had disregarded, in a certain way, the medical code of ethics! It is a fair question to ask whether the American Society of Microscopists is a society of microscopists, or a society bound to uphold the medical code of ethics.

Probably the Society as a whole is in no wise responsible for the facts as we have learned them, indeed, we are sure that very few of the members were aware of them. Nevertheless, we have no reason to doubt the truth of the rumor which has reached us, and we publish it for what it is worth, trusting that no outside influences will be permitted to interfere with the business of the Society. We merely wish to point out some possible rocks ahead, upon which other societies have already stranded. Prof. McCalla, who was elected President, is certainly an excellent man for the position, and one who will do honor to the Society.

A rather amusing incident of the Elmira meeting is told by an "eye-witness." It seems that a certain gentleman, going out for a walk in company, had for a companion a lady whose interest in the microscope proved to be greater than her escort had supposed. In fact, the lady was a very near relative of a well-known dealer in microscopes. The gentleman remarked that he thought he had one of the best microscopes made. The lady inquired whose make it was. He answered, "A ——— & ———." "A ——— & ———," exclaimed the young lady, "O, they are no good! The only really good stands are made by ———!" Now, it so happened that the representative of the manufacturers whose meritorious labors were thus conspicuously undervalued, overheard this conversation, and caused some consternation by turning around and asking, "What is that you say Miss ———?"

The Montreal meeting was a most profitable one in every way. The papers presented were, with very few exceptions, of high quality and value, the attendance was large and 314 new members were elected, making the entire membership about 2,100, —which ensures a publication-fund large enough to make the *Proceedings* a valuable and creditable publication. Our space does not admit of the publication this month of all the matter we have in hand pertaining to the Montreal meeting, so a portion will be held over for the next issue.

We take pleasure in calling attention to some preparations of the Rev. Mr. Hervey, of Taunton, Mass., showing the methods of fructification of the marine algæ. He had with him at Montreal, a second series of slides illustrative of the subject, which we found to be very instructive. They must prove of great practical value to beginners in the study of marine algæ, and doubtless also to others who are more advanced, for it requires skill in preparing the sections, and a careful selection of the plants in the proper stage of growth, to obtain satisfactory slides of this kind.

——o——

INVESTIGATIONS OF THE LOWER FUNGI.—Prof. C. V. Nägeli has published a valuable book on this subject ("Untersuchungen über Niedere Pilze"), embracing the results of his own researches and those of Dr. Hans Buchner. We do not propose to notice the work at length, but so many persons are now interested in the study of fungi in relation to disease that an announcement of the contents of this late publication may be desirable. There are three articles by Nägeli, treating of the nutrition, the movement, and the changes of different minute fungi; and five by Buchner, embracing experimental studies on the relations of various

forms to diseases, the disinfection of clothes and effects, contributions to morphology, and a critical and experimental consideration of the constancy of pathogenic forms.

CORRESPONDENCE.

TO THE EDITOR.—E. P., who inquired in July about mounting plant-hairs and fungi, will find balsam a satisfactory medium for all such objects as are rather hard, and contain but little water, but all the more, delicate parts of plants, and small fungi, require a watery medium to make the best preparation. glycerin-jelly prepared to be fluid at common temperatures but stiff at 45° F., is, next to balsam, the most convenient and useful medium, if used as follows: The object, if not already soaked in glycerin or in a thin jelly long enough to be saturated, should be arranged on the slide, and covered with the jelly a short time before the cover-glass is put on, then, if warmed gently on the hot plate, or over a lamp till the jelly is very fluid, all air bubbles will pass out without the slightest difficulty. Allow the slide to cool, and if there is a large surplus of jelly, remove it with a knife, or a scraper, then hold the slide under the top of a water-cooler, which sets the cover on so that with a camel-hair brush, every smear may be removed while the water is running, leaving a clean edge; then dry and run a balsam ring over the edge of the cover, and the slide will be permanent. All preparations mounted in watery mediums not hermetically sealed from the air by a resinous or non-volatile covering, will spoil by evaporation.

W. H. SEAMAN.

NOTES.

—Probably some of the finest preparations of embryo chicks that can be found are made by Mr. J. Lee Smith, of this city. Some of his slides seem to be absolutely perfect. He has been at work on the preparations for a long time, and although we thought he was remarkably successful a year ago, the slides he now makes are much superior to his former ones. Yet he says we have not seen his best! We are not aware whether the slides can be purchased, but if not, we hope they will be placed on sale; for they should become known to microscopists throughout the country.

—Mr. Crisp described a "Jumbo" microscope, at the Royal Microscopical Society some time ago. It stood 4 feet high, had a tube 4 inches in diameter, and weighed 1½ cwt. It was made about fifty years ago. How such a stand would delight Mr. Stodder!

—Mr. P. Mégnin has drawn attention to the liability of mistaking other encysted worms for *Trichina spiralis*. Care should be taken by all who have occasion to examine encysted worms in man or the the lower animals, to make out their forms and peculiarities; for not all encysted and coiled up worms are trichinæ.

—Mr. T. W. Engelmann has carried out some experiments on bacteria and spirillas, which lead to the somewhat remarkable conclusion, that certain spirillas may derive sufficient oxygen to support life from certain greenish bacteria, which disengage that gas.

—Mr. A. D. Michael, states that to obtain the best effects with polarized light on a dark ground, objects should be mounted in glycerin. In this he is not fully supported by the opinions of other observers; but probably the same objects were not compared, Usually balsam is preferable for polarized light, but some detail is sure to be lost when delicate objects are mounted in balsam. Mr. Michael seems to allude particularly to vegetable tissues when he recommends glycerin.

—A method of preparing minute entomostraca, such as water fleas, but also applicable to other small animals, such as mites and spiders, was recently described by Mr. M. M. Hartog, before the Royal Microscopical Society (London). In outline, the process was as follows:—

The specimens were killed by adding a few drops of osmic acid to the water, when they fell to the bottom they were taken up and placed in alcohol of 30 per cent., from which they were transferred to alcohol of 50 per cent., then to cochineal solution in 70 per cent. alcohol, then washed repeatedly in 70 per cent. alcohol, then placed in 90 per cent. and finally in absolute alcohol. Then a small quantity of oil of cloves was poured in the alcohol, and at the line of juncture of the two liquids, the specimens became permeated with the oil. They were then imbedded

in a mixture of spermaceti and castor oil, and sections were cut. In this way specimens were obtained with "absolutely no shrinking of the protoplasm."

—Mr. G. Stocker finds that a strong solution of potash-alum in water, will preserve the coloring matter of parts of plants. The pieces are placed in the solution for about ten minutes, then dried between pieces of blotting-paper, and passed through turpentine into balsam.

—Some time ago it was announced that certain insect-pests had been killed by the application of yeast, which acted as a parasite to destroy them. Later experiments have in some cases succeeded, and failed in others. It has been suggested that the yeast-plant itself is innocuous, but there might have been a parasite associated with it, which proved fatal to the insects. This idea seems not to be borne out by the observed facts. Prof. Hagen now believes that the yeast-plant must be in a certain stage of growth in order to prove effective, and he thus explains the failure of some of the experiments.

—Mr. W. P. Collins, of London, who probably has the best collection of old and new books treating of microscopical subjects to be found in any book-store, will send a copy of his new catalogue to any applicant. The June catalogue advertises a large number of valuable second-hand publications, and full sets of microscopical periodicals.

—There is a good article in the March number of the *Journal of the Quekett Microscopical Club* by W. H. Gilburt, F.R.M.S., "On the Structure and Division of the Vegetable Cell." The subject is treated very clearly, and, while it is quite elementary, it will doubtless be instructive to many beginners in microscopic study. The author, however, in our opinion, places too much confidence in the declarations of Flemming and Klein regarding the structure of nuclei, for it is still doubtful if their observations of the network of the "chromatin" are to be accepted as correct. There are good reasons for taking them *cum grano salis*.

—Dr. L. Brewer Hall has described a form of eye-protector for use with the microscope, which he thinks possesses some advantages over others. He describes it as follows: "The form that I now propose consists of a small, opaque disk near the eye, supported by a wire extending from its outer edge downward to a point on the tube low enough to be out of the way of the nose, then bent upward, parallel to the tube but not touching it, and attached to a ring near the top. I made mine of a piece of brass wire, No. 18, about 45 centimetres long; a loop at one end 4 centimetres in diameter, covered with a piece of black paper folded over and gummed down, forms the disk. At the other end, I made a ring to fit the draw-tube, and then bent the intermediate wire. I attach mine below the flange, on the draw tube, where there is no lacquer to be scratched, but if it should be thought desirable to attach it above the flange then the ring ought to be covered with chamois, so as not to wear the polish."

—There is a very interesting article in the April number of the *Northern Microscopist* about "The Cypris and its Fossil Ancestors" by R. T. Burnett, F. G. S. Beginning with a short description of this minute entomostracan the author refers to its almost universal distribution in rivers, lakes, salt marshes and in the seas, and mentions the deposits of sand and clays about the great lakes in which fossil shells of species that are now living are found. Then follows a summary of the work of the "Challenger" expedition with reference to this subject. Cypris has been found in the globigerina ooze of the Atlantic at a depth of 1,452 fathoms. From twenty-nine dredgings, at depths greater than 500 fathoms, fifty-two species were found. At great depths the species are much less numerous. The fossil ancestors of the cypris can be traced back as far as the oldest stratified rocks—being found in the Laurentian and Cambrian formations—with occasionally a break in the continuity. The ostracoda were most abundant during the mesozoic just preceding the cretaceous, where they were about as numerous as they are at the present time. For a satisfactory *résumé* of this subject, the reader is referred to the original article.

—The fifth fascicle of the "Synopsis of Diatoms" is now in the hands of subscribers. It contains twenty-six plates, with 449 figures. The total number of plates now issued is 104, containing 2,658 figures. The sixth fascicle, which will complete the work, will be out in a few months.

NOTICES OF BOOKS.

Consumption: Its causes, Prevention and Hygienic Management. By W. H. Smith, M. D., Ph. D. St. Clair, Mich. (Pamphlet, pp. 11.)

Hydrurus i jego Pokrewienstwo: Monografija przez Dra. J. Rostafinskiego. Z tablica. (Mit einem deutsch verfassten Résumé.) Kraków: w. drukarni Universytetu Jagiellonskiego pod zarzadem Ignacego Stelela. 1882. (Pamphlet, pp. 34.)

This monograph, which is illustrated by a fine large plate, treats of the development of *Hydrurus*, a genus of algæ. The process of cell division was carefully studied by the author. He finds that this process takes place at night, beginning about midnight. The relations of *Hydrurus* to other algæ similar to it are discussed at some length.

The Coues Check List of North American Birds. Second Edition. Revised to Date, and entirely Rewritten under Direction of the Author, with a Dictionary of the Etymology, Orthography, and Orthoepy of the Scientific names, the Concordance of Previous Lists, and a Catalogue of his Ornithological Publications. Boston: Estes & Lauriat, 1882. (8vo, pp. 165.)

This book is nothing less than its title indicates—a check-list of birds and an ornithological dictionary combined. The first edition was published in the year 1873, soon after the appearance of the "Key to North American Birds," by the same author; but it was then a mere list of birds, and a far less pretentious work than the present one. Since that time one hundred and twenty names have been added to the list, but so carefully was the work on the first edition carried out that not more than ten names have been eliminated.

The work as it now appears, bears likewise the impress of extreme care in its preparation. Each of the 778 names of birds has been critically examined as regards its derivation and proper pronunciation; and in the chapter of "Remarks on the Use of Names," are to be found suggestions about the etymology, orthography and orthoepy of names, which are invaluable to the collector and student of birds. In the Introduction the purpose of the check-list is stated to be two-fold: "First, to present a complete list of the birds now known to inhabit North America, north of Mexico and including Greenland, to classify them systematically * * * secondly, to take each word occurring in such technical usage, explain its derivation, significance and application, spell it correctly, and indicate its pronunciation with the usual diacritical marks."

A notable feature of the book is that the full name of the learned author, Dr. Elliott Coues, does not once appear in it.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Wanted—To exchange, good slides correctly named, or material for mounting for same.
F. C. SMITH, Bridgeport, Conn.

Wanted, material containing Pleurosigma angulatum, Nitzschia sigmoidia, Frustulia Saxonica and Amphipleura pellucida. Mounted diatoms or material in exchange.
T. CHRISTIAN,
108 Virginia, St., Richmond, Va.

Wanted—Diatomaceous material from New Hampshire containing *Amphipleura Lindheimeri*, in exchange for materials from North of Ireland.
WILLIAM A. FIRTH,
Whiterock, Belfast, Ireland.

Striatella unipuncta, *Rhabdonema Adriaticum*, and other first-class crude material, to exchange for named diatoms and first-class material—prepared and particularly foreign material preferred.
M. A. BOOTH, Longmeadow, Mass.

Mounted crystals for the poloriscope, diatoms (a fine collection), fresh-water algæ, foraminifera, in exchange for other well-mounted objects. Send specimens and full value will be returned.
R. HITCHCOCK, 53 Maiden Lane, New York.

Rubber cement of my own manufacture, in exchange for good slides.
EUGENE PINCKNEY,
Dixon, Ill.

Well-mounted sections of Rat's tongue, Rabbit's eye and Cat's muscle for other well-mounted objects.
F. B. CARTER,
519 Gates Ave., Brooklyn, N. Y.

On receipt of a well-mounted slide, I will send a slide of crystal, (for the polarizer) of any of the rare vegetable products which I may have; will send list of same on receipt of postal request.
J. KETCHUM, Jr.,
P. O. Box 877, New York City.

Wanted.—Animal parasites, Ixodes, Acari, etc., either mounted or unmounted. W. A. HYSLOP,
22 Palmerston Place, Edinburg, Scotland.

Unmounted objects, Foraminifera, Spicules, Plant-hairs, Zoophytes, etc., in exchange for other objects, mounted or unmounted.
E. PINCKNEY, Dixon, Ill.

Fig. 1.

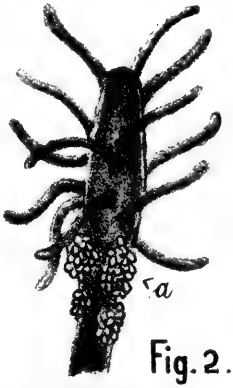

Fig. 2.

Fig. 3.

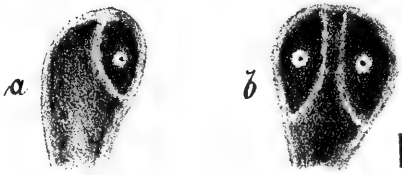

Fig. 4.

Fig. 5.

Fig. 6.

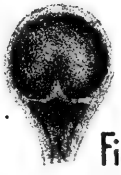

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 12.

Fig. 13.

Fig. 14.

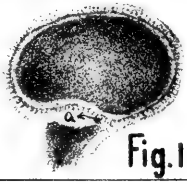

Fig. 15.

Fig. 16.

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Development of the Planula of Clava Leptostyla, Ag.*

BY J. H. PILLSBURY.

On the tangled masses of sea-weed (*Fucus*) which grow in profusion over the rocks of our New England coast between high and low water, may be found little clusters of the orange-yellow polypites of one of our commonest hydroids, *Clava leptostyla*, Ag. Fig. 1 of the plate represents a portion of the sea-weed with such a cluster of polypites, of natural size. As the incoming or receding tide floats the long stems of the sea-weed back and forth over the rocks, the little animals may be seen gracefully moving with the waves, or suddenly contracting their tentacles on the approach of danger.

All the polypites of the same cluster are connected at the base by minute, thread-like fibres, called stolons, which unite them into a single colony. Each polypite consists of a tube with an oral opening at the free end, which is surrounded for some distance down the slightly swelling body with a number of stout, and somewhat scattered, tentacles (fig. 2). Just below these tentacles the body contracts into a perceptibly narrower stem, which maintains a uniform size until just above its union with the stolon. At the point of contraction just mentioned there will be found in early summer, of various shapes and sizes, clusters of minute buds, which often extend down the stem for a distance of 2 mm. These buds (fig. 2 *a*) are formed by the outward growth of the body-wall, and at first do not differ in appearance from the general tissue of the body.

Usually before the bud has reached its full size, one or two small, transparent spots appear in the outward and larger end of the bud (fig. 3 *a* and *b*). These are the germinal vesicles, and each contains a distinct spot called the germinal dot. This I have been able to distinguish only by the aid of carmine staining, but under such treatment it becomes very distinct. As the buds continue to grow the sarcode surrounding this germinal vesicle becomes more dense than that in other parts of the bud, and a little later the ovum separates from the general mass of the bud, which is now called the spadix (fig. 4 *a* and *b*). The ovum continues to increase in size at the expense of the spadix until it nearly fills the sac, the spadix being meanwhile reduced to a cup-shaped termination of the stem of the sporosac. Such of the buds as had two germinal vesicles will, of course, under favorable circumstances, develop two ova within the same sporosac (figs. 4 *b* and 5 *b*).

When the ovum has reached its full size and fills the whole sporosac, the ovum becomes so opaque as to make the germinal vesicle obscure, and render observation in regard to its changes impossible. The ovum itself, however, soon divides into two cells, the division commencing by a depression at one side, which becomes gradually deeper and deeper until the two cells are entirely separated (figs. 7 and 8). Each of these cells again divides into two, and this is repeated

* Read before the Section of Histology and Microscopy of the A. A. A. S., at Montreal.

until the ovum passes through the mulberry state and assumes a granular appearance, beyond which time it is impossible to follow the cell-division (figs. 9 to 13). At this stage the coat of the embryo begins to show signs of separating into the two layers which are characteristic of the body-wall of the Cœlenterata (fig. 14), and the body of the embryo shows slight changes of form, from time to time elongating itself into a somewhat worm-like form.

It is at this point that the results of my observations differ from those of others who have written upon the development of the hydroids. The elder Agassiz says he has never been able to discover vibratile cilia while the embryo is within the sporosac. I have, however, found not only well-developed cilia on the surface of the embryo, while as yet there were no signs of rupture of the sporosac, but I have also found them in motion, producing vortical currents within the sporosac, as shown by the direction of the arrow (fig. 15 *a*). The embryo assumes an arched position as seen in fig. 14, and seems to be endeavoring thus to burst open its prison wall. In this stage the motion of the cilia becomes very energetic beneath the arch, as if to assist in bursting the wall of the sporosac. After successive and finally successful attempts, the larva comes forth in the planula form, and moves about freely for some time by means of its thick covering of cilia (fig. 16). At this time the planula shows no signs of a mouth, and seems to be moving about in quest of a resting place. In this state the outer layer of the body-wall shows a quite distinct cellular structure under treatment with staining fluids. After moving about freely for a short time, the planula attaches itself to some object by the end which has been posterior in its free motions, a mouth opens into the previously formed body-cavity, and surrounding this mouth a number of tentacles are developed.

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A New Thuricola.

BY DR. A. C. STOKES.

In his splendid "Manual of the Infusoria," Mr. W. Saville Kent has subdivided the genus *Vaginicola* into several groups, primarily on account of certain structural characteristics, and also, as he expresses it, to "assist the student in his indentification of the numerous species." In the latter he has been eminently successful, for, until he took the matter in hand, we had *Vaginicola* with a valve and without, *Vaginicola* upright, decumbent, sessile, and stalked in the most perplexing confusion. One system of classification stated that if the body was pedicellate and the sheath sessile, *Vaginicola* being in this condition five times out of ten, the specimen was a *Tintinnus*, and *Tintinnus* was run down only to find that every known species is free-swimming and marine. Another stated that everything with the lorica fixed by its posterior extremity is a *Cothurnia*, and still another that the sheath of every *Cothurnia* is stalked, while one more informed the reader that every *Vaginicola* has the test adherent by its side. This point reached, although a microscopist soon becomes the most patient of human beings, nothing remained but to follow the advice of Mr. F.'s Aunt, and chuck the thing out o'winder. Kent has righted affairs by directing that both stalked and sessile zooids in an upright, sessile sheath, shall be relegated to the genus *Vaginicola*, forming for the decumbent lorica a new genus, while the not uncommon valvate species, *V. valvata*, with two others, he has collated under *Thuricola*, a new generic title.

For two seasons the writer has observed attached to the leaflets of *Ceratophyllum*, isolated specimens of a loricate and valvate zooid, presenting characteristics which mark it a new species of Kent's *Thuricola*. One of its specific peculiarities, in addition to the valve-like organ

closely resembling that of *Thuricola* (*Vaginicola*) *valvata*, consists in a delicate membrane attached to the inner wall of the lorica opposite to the valve, and at a point about midway between the origin of the latter and the orifice of the sheath. It is shown in optical section in figure 38. It extends arcuately upward and inward, and receives the edge of the valve as it descends upon the contracted animal. It is flexible, bending at the touch of the ascending zooid, but is rigidly attached to the lorica, and is stiff enough to make a well-defined indentation in the soft substance of the animalcule. It supports the edge of the closed valve at about the beginning of its middle third. The valve, although the connection could not be demonstrated,

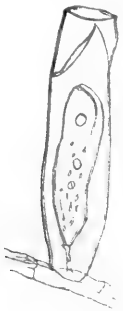

FIG. 38. THURICOLA INNIXA, *n. sp.*

is probably attached to a ligamentous prolongation of the body, since it begins to rise before coming in contact with the expanding zooid.

Thuricola innixa, n. sp. Lorica sessile, transparent, sub-cylindrical, four to five times as long as broad, truncate, and somewhat tapering posteriorly, bearing at some distance from the orifice an internal valve-like appendage as in *T. valvata*, and an opposite, rigidly attached, but flexible, membranous organ projecting arcuately inwards, and acting as a support to the edge of the descending valve, the wall of the lorica being dilated laterally immediately behind this, in optical section, bristle-like valve-rest; body pedicellate, hyaline, projecting when extended one-third its entire length beyond the orifice of the lorica; pulsating vesicle anterior, contracting once in fifteen seconds. Hab. Pond water, attached to the leaflets of *Ceratophyllum;* not common.

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The Microspectroscope.*

The spectroscope is an instrument for analyzing and comparing light from different sources. It consists essentially of a narrow slit through which the light to be examined first passes, a lens focussed upon the slit to render the rays parallel, a prism to decompose the light, and a telescope for magnifying the spectrum for examination. The ordinary laboratory spectroscope of the chemist gives a spectrum only a few inches in length, but in order to map the lines in the

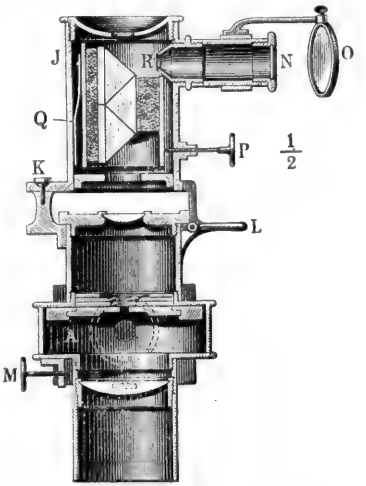

FIG. 39. ZEISS' SPECTRAL-OCULAR.

solar spectrum far greater dispersion is required, and the light passing through the narrow slit of one of the largest spectroscopes has been spread out into a spectrum over twenty feet in length.

The principles of spectrum analy-

* Read before the New York Microscopical Society.

sis may be readily illustrated by a few simple experiments. We have here the colorless flame of a Bunsen burner. I take a platinum wire with some common salt upon the end This

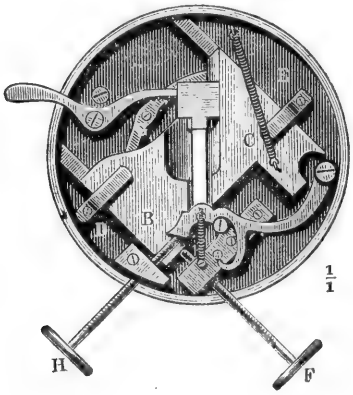

FIG. 40. SLIT OF ZEISS SPECTRAL-OCULAR.

colors the flame yellow. Examined with a spectroscope we find only a single yellow line indicating the presence of sodium. Strontium and lime it their characteristic colors. The spectroscopic examination of these flames shows that the lines produced by each element occupy different positions in the spectrum, so that by measuring the places of the lines in the spectrum one can readily determine the composition of the flame that produces them. Most metals, however, require the more intense heat of the electric arc to develop their characteristic lines, and a few elements, as carbon and boron for example, are only volatilized in the intense heat of the sun.

The temptation to dwell upon the applications of the spectroscope in solar and stellar physics is great, for this subject is, to me, one of the greatest interest. I would be pleased to review the progress of this branch of investigation during the past twenty years. In no department of physical research have important discoveries followed in such rapid succession; in no department have results of such

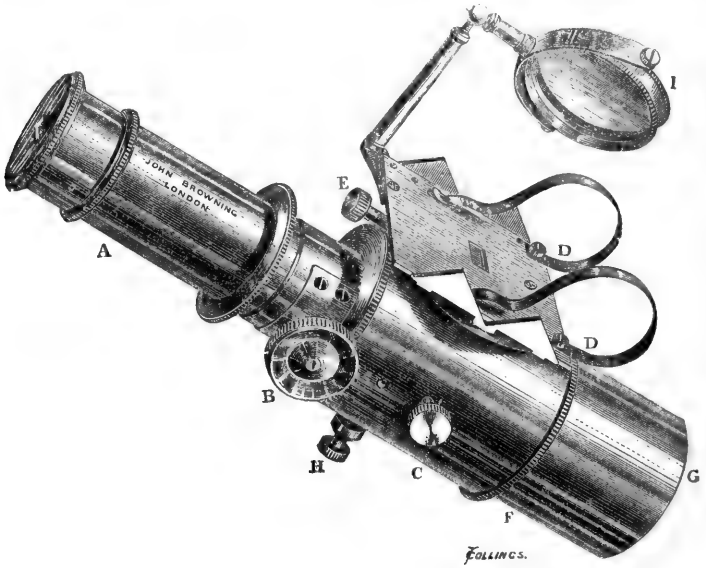

FIG. 41. SORBY-BROWNING MICROSPECTROCOPE.

give a red flame, baryum a green, potassium a violet, and several other metals are sufficiently volatile at the temperature of the flame to impart to a surprising character been so readily revealed. I would be glad to speak at some length of the recent researches upon the chemical and physical con-

dition of the sun and stars, the nebulæ and comets. We can readily understand that the spectroscope may reveal the composition of these distant suns and masses of fiery vapor, but it has told us much more than that; it has enabled us to measure their rate of movement toward us or from us, it has afforded a measure of their temperature, the pressures at their surfaces, the distribution of the elements about their centres, in fact, we are enabled to study them from a distance of millions of miles with the same certainty of our results, as when we test a mineral in our laboratories. Every ray of light which comes to us from the depths of infinite space, though it may have travelled years and years before it reached our world, bears the impress of the physical and chemical conditions of the sphere from whence it came. It is the labor of the scientific student to interpret its silent testimony. As we go out beneath the starlit sky, and think that every ray of light from every shining world brings us a story like this,—a history of the birth and development of worlds, or systems of worlds, or nebulous stars—perhaps we may realize what the spectroscope has already done for chemistry and physics.

The microspectroscope is of somewhat different construction from the larger instrument. In this instrument only a small spectrum is necessary, but the definition must be good — the faintest absorption of light should be noticeable in any part of the spectrum. The instrument I have to show you this evening is a spectral-ocular by Zeiss (figs. 39 and 40). Fig. 39 represents a sectional view of the instrument. It will be seen that the lower part is an ordinary eye-piece with its two lenses, but in place of the ordinary diaphragm there is a slit, adjustable in length and breadth, shown in fig. 40. By studying this figure the method of adjustment, with two screws, *F* and *H*, and the projecting lever which carries a reflecting prism, can be readily understood.

The upper part of the instrument swings about the pivot *K*, so that by opening the slit the eye-piece can be used for focussing an object, the slit being the diaphragm. The upper portion contains the prisms, and also a scale in the tube *N*, which is illuminated by the mirror *O*. The image of the scale is reflected from the upper surface of the last prism to the eye, and when properly adjusted gives the wave-length of the light in any part of the spectrum. There is also a supplementary stage, not shown in the figure, upon which a specimen can be placed, and its light thrown up through the slit by reflection from the prism on the lever shown in fig. 40, along side of the light from the object on the stage of the microscope, thus enabling the spectra from the two sources to be directly compared.

The Sorby-Browning microspectroscope is shown in fig. 41. *D* is the supplementary stage, and *C* and *H* are the screws for adjusting the slit. The tube *A* contains the prisms, and *B* is a screw for focussing the spectrum. There is no scale of wave-lengths with this instrument, but there have been several methods of mapping the spectra devised, which can be readily applied. Another form of microspectroscope has been devised by Mr. Sorby in which the object glass that focusses the slit is above the prism instead of below it. This arrangement is said to improve the definition. A cylindrical lens collects the light from the slit. A micrometer is also provided to indicate wave-lengths. This miniature microspectroscope is made in England, by Mr. Hilger.

The application of the spectroscope to the examination of solutions or fluid compounds, is based upon the discovery that some coloring matters exercise a selective absorption upon certain colors in the spectrum, manifesting their presence by dark bands in constant positions. It is well

known that the color of a transparent object is due to the absorption of certain colors from the light—thus, a red glass permits the red rays of the spectrum to pass through it while it is opaque to all the others. Hence, if we examine with the spectroscope the light from such a glass we find that the spectrum consists only of a band of red, all the other colors being absent. Such a spectrum might be given by a large number of totally different substances of a red color, since there is no distinguishing characteristic of a spectrum formed by a general absorption of this kind. But there are many colored solutions and compounds that exercise a selective absorption upon the light that enters them, that is to say, when the transmitted light is analyzed by the prism it shows, not a single band of color as in the former case, but a continuous spectrum with one or more dark bands crossing it, indicating what colors have been absorbed. The position of these bands is constant for the same compound; hence, we have a means of detecting certain compounds, and analyzing mixtures of them, by the character of the light they transmit. Take, as an example, the coloring matter of blood, the spectrum of which will be shown this evening. There are two distinct, dark bands in this spectrum which always occupy the same position. As an illustration of the ease with which two coloring matters may be distinguished in a solution, we may allude to the experiments of Mr. P. Petit in studying the coloring matter of diatoms. It has long been known that when certain species of diatoms are dried, the brownish, or yellowish, endochrome changes to a bright-green —such a change is particularly noticeable in *Melosira*, and in the beautiful *Aulacodiscus Kittonii*, of which I have an excellent collection illustrating this fact, and doubtless it is true of many other species. An examination of the spectrum of the coloring matter of diatoms known as "diatomine," has afforded an explanation of the change of color, and has shown that diatomine is a mixture of the two coloring matters which are common throughout the vegetable kingdom, phycoxanthine and chlorophyll—the former is yellow, the latter green. It is clearly shown by Mr. Sorby's investigations on the coloring matters of plants, described in the *Proceedings of the Royal Society*, 1873, p. 442, that each of the above-named coloring matters, as distinguished in diatoms by Mr. Petit, is composed of several distinct coloring matters, but to illustrate the application of the microspectroscope to analysis of this kind, we may assume the correctness of the distinction recognized by Mr. Petit.

According to his experiments, the different colors of diatoms are due to the different relative proportions of these two constituents. For example, *Melosira* and *Navicula* contain a larger proportion of the green than *Nitzschia* or *Diatoma*. This is clearly shown by the spectra, which are represented on the board.

The first spectrum represents the absorption due to chlorophyll, the second is that of phycoxanthine. Observe the difference in the position of the dark bands in the two spectra; in the latter the bands is further to the left.

The third spectrum represents the coloring matter of *Melosira nummuloides*. The three fainter bands of chlorophyll are present, and the broad, black band indicates the presence of both phycoxanthine and chlorophyll. In the fourth figure there is not a sufficient quantity of the chlorophyll present to develop all of the faint bands characteristic of that substance, but that some is present is shown by the broad band on the left, which also shows the presence of phycoxanthine.

By the aid of the spectroscope and chemical analysis, Mr. H. C. Sorby, in the article already referred to, has shown the presence of twelve distinct colors in the red, olive, and green

algæ. The examination of blood with the microspectroscope is of great importance in legal proceedings. To Prof. Stokes we are indebted for some very elaborate investigations of the coloring matter of blood. His results were published in the *Proceedings of the Royal Society*, 1864. He found that when blood was treated with some reducing agent, such as a solution of ferrous sulphate containing tartaric acid, or stannous chloride, the color was changed from a bright scarlet to a purple. This change in color is accompanied by a modification of the spectrum, the two bands characteristic of oxygenated blood being replaced by a single band occupying a position between the places which they held. He named the bright-red constituent scarlet cruorine, and the other purple cruorine. When the reduced or deoxydized blood is shaken up with air the scarlet cruorine is again formed, and shows the two-band spectrum as before. These changes are quite characteristic of blood, but there are still others, brought about by acting upon blood with acid and alcohol, which render spectroscopic examination still more conclusive of the nature of the fluid under examination.

The delicacy of the test for blood by the microspectroscope is quite remarkable. A scarcely visible stain upon a piece of white paper, not more than $\frac{1}{1000000}$ of a grain, will show the bands, but it is more satisfactory to work with solutions of blood. A quantity not greater than $\frac{1}{100}$ of a grain of blood in a cell measuring $\frac{1}{10}$ of an inch in diameter by half an inch deep will show the bands very clearly.

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A New Form of Constant Pressure Injection Apparatus.*

BY PROF. WILLIAM LIBBEY, JR.

In studying the circulatory system, the means of injection are an indispensable aid. This operation can be performed in several different ways, but the most satisfactory method would, of course, be that which would in the simplest manner utilize the materials used, and at the same time place them under the most perfect control of the operator.

In the piece of apparatus described below, the wants of my laboratory have been especially consulted, and the object kept in view was the construction of a machine which would perform the most delicate injections in a satisfactory manner.

In a sense, it may be said that this object has been realized ; but, as the element of good judgment can never be made part of a machine, the degree of success will still be in proportion to the skill in manipulation.

All such machines must have a certain similarity in their construction, but may differ essentially in the arrangement of their several parts, and for this reason no great originality is claimed for the apparatus ; the method of the operation in the machine under consideration is as follows :—

We will suppose the animal, or organ, to be injected to have been prepared as is usual, and placed over a water-bath arranged to secure a proper degree of temperature during the operation ; the injection-mass having been also previously prepared and placed in a three-mouthed Woulffs-bottle (prepared as a wash-bottle with closely-fitting rubber corks), which should, of course, be placed over a water-bath to keep the mass liquid.

The source of the power utilized is twenty pounds of mercury, which, by changing position from a higher to a lower level, forces the air out of one of two globular glass filtering funnels alternately, as one is placed below or raised above the level of the other, which should be kept stationary. These two filtering funnels are supported on iron rings with clamps which can be attached to two iron

* Read before the Section of Histology and Microscopy of the A. A. A. S., at Montreal.

rods at any given height. The iron rods should be about 36 inches high, being held in their places by a framework that rises on the back part of a wooden platform which rests upon the table (or may be built into the wall, or placed between two shelves far enough apart in a closet in the laboratory), and serves as a convenient place for any accessory apparatus or instruments.

The funnels referred to above, are connected at the bottom of each by a rubber tube, and have stop-cocks above the points where the tubing is attached. The opening at the upper part of these funnels is closed with rubber corks, through which a glass tube is placed after having been once bent at right angles.

The means of securing the operation of the currents of air, in such a manner as to perform their work properly, is an arrangement of three-way stop-cocks of a peculiar construction. These stop-cocks are each so constructed that when turned in one position they have the form of a regular spigot, while, by a quarter turn from that position, a straight connection is made through the body of the stop-cock to a tube opening at that point.

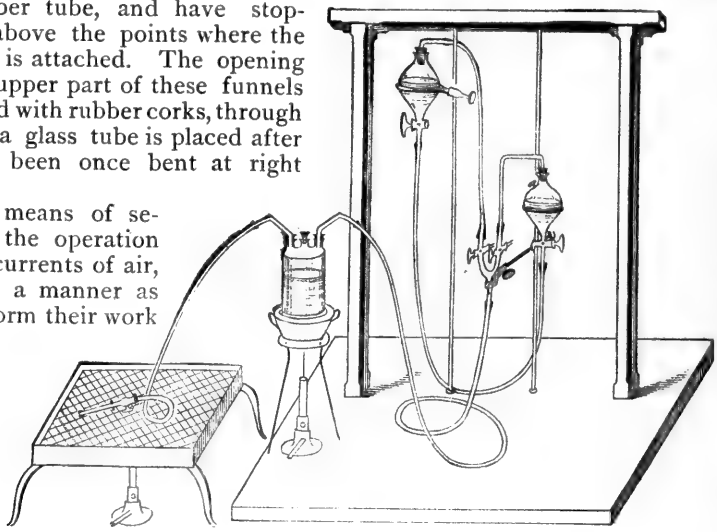

FIG. 42. CONSTANT PRESSURE INJECTION APPARATUS.

Two of these stop-cocks are placed, one on each of the upward branches of a glass tube having the form of the the letter Y. This arrangement affords the means of transmitting a current of air under pressure through that stop-cock which may be turned so as to open a straight connection through it, when that branch of the Y of which it forms a part has been connected with the glass tube at the top of the filtering funnel, from which the air is forced by the flow of the mercury to it from the other funnel, which should occupy a higher position. It also affords the means of allowing a current of air to flow to the surface of the mercury in the higher vessel, through the other stop-cock which should be turned so as to afford ingress to the air; this will be secured when the stop-cock is placed in a position at right angles to that of the first described stop-cock. This branch of the Y-tube should be connected with the tube at the top of the other filtering funnel. The lower branch of the Y-tube should be connected with the short arm of the bottle containing the injection mass.

All the joints made with the tubing should be securely wired, and all the other connections made as tight as possible.

The Y-tube described above should be securely supported by extension test-tube clamps, attached to the iron rod to which the stationary filtering funnel has been fixed, and below the funnel.

The long arm of the bottle con-

taining the injection-mass should be attached to the nozzle stop-cock, which fits the canulæ to be used in the injection.

Now, we shall suppose that the mercury has been placed in the stationary filtering funnel, and this latter firmly fixed a little above the middle point of one of the iron rods.

The stop-cock of this funnel should be turned so as to prevent the mercury flowing from it, then the three-way stop-cock connected with it should be turned so that the air may have access to surface of the mercury, and the other three-way stop-cock turned so that the air from the funnel with which it is connected will flow directly through the glass tube to the Woulffs-bottle.

Then if the second filtering funnel be placed in a lower position than the first above described, and clamped securely, the machine is ready for use. If the mercury should then be turned on it will force the air out of the lower filtering funnel, and this air will then act upon the injection-mass, forcing it along in proportion to the difference in level of mercury, or the amount of mercury turned on.

If a larger quantity of injection-mass is required than can be discharged from the Woulffs-bottle by once emptying one funnel into the other, after the flow of mercury has been stopped by turning the stop-cock of the lower funnel an additional quantity of the fluid can be poured through the central mouth of the Woulffs-bottle.

The positions of the three-way stop-cocks should now be reversed to permit the current of air to act from the other funnel upon the injection mass.

Then the funnel, which is full of mercury, should be raised to a position on its rod as much above that of the stationary funnel as it was below it before, when it will, in its turn, become the source of power when the mercury is turned on. Thus the operation may be proceeded with, and by repeating this simple process an injection may be performed, lasting any reasonable time, with very little trouble or interference on the part of the operator, and, as far as my experience goes, with great satisfaction.

It will be readily seen that absolute constancy of pressure is not even obtained in this instance, because the shifting lines of level of the surface of the mercury in the firmly fixed funnels introduces a small error. This might be overcome by suspending the funnels from springs, so adjusted that, as the mercury changed its level a compensation would be brought about by a change in the position of the funnels; but after having tried the firmly fixed funnels, and not having experienced the slightest difficulty from this source of error, I am inclined to believe that a change would be an almost needless refinement of accuracy, and, in addition, would somewhat doubt the prudence of having such a weight of mercury suspended in that manner.

The piece of apparatus has been thus described somewhat in the hope that histologists will find in it an aid in their investigations such as it has been to myself.

HISTOLOGICAL LABORATORY,
PRINCETON, N. J.,

The Physiology of Variable Apparent Magnification by the Microscope.*

BY W. LECONTE STEVENS.

In estimating the size of an object viewed in the microscope, it is commonly assumed that the image is seen as if at the distance of easiest vision, which is taken to be ten inches. The invalidity of this latter assumption is strikingly shown in the table of estimates exhibited and discussed by Prof. Brewer, in his recent

* Remarks made before the section of Physics of the A. A. A. S., with additions by the author.

paper, read before the American Association for the Advancement of Science, and noticed in the September number of this JOURNAL.

It is well known that the distance of easiest vision is variable, during the life of the same individual. The "near-point" for a normal eye, varies from three inches for a child of three years, to eighteen or twenty feet for a man of eighty, the power of accommodation diminishing with increase of age. For such an eye, when in a relaxed state, parallel rays will be converged to the exact distance of the retina. If the radiant point be but ten inches distant, the sheaf of divergent rays from it, if transmitted through the same refracting medium, would be focalized behind the retina, were there not an instant contraction of the ciliary muscle, resulting in an increase of convexity of the crystalline lens at its front surface. The ease or difficulty with which this is done, depends mainly on the age of the person, if the eye be normal. The effort exerted by a little child will be far less than that of an old man.

All that the microscope can do is to increase the visual angle under which the object is seen, and hence increase the size of the retinal image. The extent to which this may be advisable depends upon several considerations well known to microscopists. Since the visual angle is simply the measure of the difference of direction between two rays passing axially through the crystalline lens, from opposite marginal points of the magnified image as seen through the eye-piece, it is quite possible for this to remain sensibly constant, while the refracting power of the crystalline lens varies. The adjustment of the eye-piece, or the distance of the eye from it, may vary while distinct vision is retained, the limits of variation depending upon the power of accommodation in the eye of the observer. For a hypermetropic eye, the rays from a given crossing point near the focus of the eye-piece may emerge from the latter either parallel, or slightly convergent, or divergent, and yet be distinctly focalized on the retina in consequence of appropriate action of the ciliary muscle.

The interpretation which we put upon a retinal sensation is quite unconscious, and always accompanied with equally unconscious interpretations of attendant muscular sensations. The experience of the individual is the only guide in reaching visual judgments. It is not at all remarkable that different persons should vary in the interpretation they put upon sensations produced under the same external conditions, although the general effect of controlling the condition of the eye among them may be much the same. The writer has elsewhere detailed numerous experiments on this subject. (See *American Journal of Science*, November and December, 1881, April and May, 1882.) The result may be briefly stated by saying that, while the visual angle remains constant, an increase in the contraction of the ciliary muscle, or of the internal rectus muscles if both eyes be employed, produces the illusion that the object is much smaller and nearer; under such conditions, the apparent diminution in size, together with imperfect focalization, may produce as a secondary effect the illusion that the visual angle has been diminished, and the imagination that the object is more distant. Thus the unmistakable illusion is that of diminution of size, and this may be coupled with great lack of determination in the judgment of distance. Upon the writer the most usual effect is that of diminution of distance.

The internal rectus and ciliary muscles are supplied from the same nerve, and their contractions are usually simultaneous, though disassociation to a limited extent is by no means impossible. The relaxation of these muscles, with contraction of the external rectus, produces

the illusion of greater distance and size, for the object retinally pictured. This is in accordance with the laws of association; for under ordinary circumstances, near vision requires contraction, and distant vision relaxation, of internal rectus and ciliary muscles; while unusual contraction of the external rectus muscles is not unfrequently necessary in the ordinary use of the stereoscope, involving discomfort and an illusion of increased distance in the binocular picture.

All our judgments, whether visual or otherwise, become vitiated when conditions are very different from those to which we are most accustomed. Prof. Brewer's 440 observers accommodated their eyes, as nearly as possible, to the same external conditions. The striking diversity in the conclusions reached by them, shows how various were the muscular conditions, under which they interpreted their own sensations. To this must be added the important fact to which attention was called by him, that for the same eye much depends upon education. The mechanic who thought the picture looked to be five feet long, and projected upon a screen, was quite unaccustomed to forming judgments with no actual objects for comparison; and in any event there was doubtless room for improvement in his visual education.

Another striking example of variation in judgment by the same person, under changed ophthalmic conditions is found in early experiences with the binocular microscope, by the original inventor of this instrument, Prof. J. L. Riddell, of New Orleans, La. In looking with both eyes at an object ten inches distant, the two visual lines form an angle of a little over 14°, and a corresponding degree of contraction of the internal rectus muscles is necessitated. The two tubes of Dr. Riddell's first binocular microscope were sensibly parallel, the sheaf of rays after passing through the objective being divided, and each half subjected to two reflections before reaching the observer's eye. In a subsequent improvement a pair of prisms were placed with the lower edges in contact, and rays transmitted with two refractions and one reflection, reaching the eyes in such manner that the optic angle was less than 14°. In either case, therefore, to adapt the eyes to this condition the internal rectus muscles were relaxed, and a slight change of adjustment in the instrument was necessary. Dr. Riddell describes the result as follows: "Thus, a mite of a wheel animalcule, one-hundredth of an inch long, will perhaps appear to be a foot off, and as large as a mouse; but bring the prisms nearer together, and tilt the oculars to correspond, and the image waxes marvelously immense; and taking a position perhaps apparently more than a hundred feet distant, the being, too small to be seen with the naked eyes, vies with the great whale of the ocean in size: wearing an aspect more awful to behold than the savage beasts of the African forests; exhibiting a complex transparent structure, more unique and wonderful than the mind of man can well conceive."

We can good-naturedly forgive a little exuberance of imagination when the reality which it accompanies is the first revelation from such an instrument as that introduced to science by Dr. Riddell.

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Death and Continuous Life in the Animal World.*

BY N. CHOLODKOWSKY.

In No. 103 of *Zoologischer Anzeiger*, for the year 1882, appeared an essay by Prof. O. Bütschli ("Thoughts upon Life and Death"), in which, referring to the normally not occurring death of the Protozoa (in the sense we use this expression for the higher animals), he started the

* "Tod und Unsterblichkeit in der Thierwelt." Translated from *Zoologischer Anzeiger*.

question of the cau e of the potentially endless life of the Protozoa, and of the unconditional, necessary death of the Metazoa. For the answering of this question he has propounded a new hypothesis. From the analogy between the phenomena of life and the processes of fermentation, he conjectures that there may be a special ferment of life, which, among the Protozoa, is always renewed by nutrition in the body; in the Metazoa, on the contrary, the ability to renew this life-ferment is restricted entirely to the reproductive cells, which are thus potentially undying, while in the other parts of the organism it is entirely used up, thus rendering the complicated (metazoic) organisms subject to death.

After careful consideration of this hypothesis of the learned author, touching upon such important general questions, and after the application of it to various low, multicellular organisms, we saw that, in some cases, we came upon contradictory evidence. How, by means of this hypothesis, is it to be explained, that with those Metazoa which present a sexual as well as an asexual reproduction (*Hydra*, for example) all cells are not undying, but a large number of them die although the supposed ferment of life, that must pass over to the successors, nevertheless spreads over the whole body and in the whole body is renewed? If all the cells of the body of such animals possess the power to produce a new indivldual, they must also have the power to produce the so-called life-ferment, and be, therefore, according to Bütschli, undying. This, however, is not the case, because some of them die.

It appears to us that the cause of the death of the Metazoa is to be found in the multicellular structure of their organization. A single cell always possesses, of and for itself, a potentiality of unending life; but so soon as the differentiating cells combine into a compound individual, they succumb within it to the struggle for existence which takes place (as Roux expresses it to the "Kampf der Theile im Organismus") which, is very irregularly waged, and at last *eo ipso* leads to the destruction of the whole, and to death. It follows from this, that it is not at all necessary for the explanation of the potentially continuous life of Protozoa, and of the inevitable death among the Metazoa, to advance a new hypothesis, as we can explain these facts by a simple and logical interpretation, namely, through the principle of the struggle for existence.

The hypothesis of Bütschli calls to mind, involuntarily, Darwin's hypothesis of pangenesis. As, according to Darwin, the hypothetical granules separated from the multiplying cells are at first supposed to be distributed in all parts of the organism, and later to be concentrated in the reproductive cells, so, according to Bütschli, the life-ferment, at first disseminated in all parts of the body, finally becomes concentrated entirely in the reproductive cells, in consequence of their exclusive ability to produce it. Hence, we may regard the hypothesis of Bütschli as a physiological paraphrase of the more morphological Darwinian hypothesis of pangenesis.

—o—

Some Vegetable Poisons.

BY T. J. BURRILL.

During several years I have occasionally noticed within the closed cells of apparently healthy plants, of divers kinds, numerous actively moving particles which in form and motion were undistinguishable from some kinds of the living organisms we call bacteria. But inorganic as well as organic particles living or dead of very minute size, immersed in a fluid, quiver and oscillate under the microscope like things of independent life. This is what is called Brownian motion. It is exceedingly difficult in many cases to distinguish these

minute particles, agitated by Brownian motion, from those of similar size and equal activity really possessing life on their own account. The first may be particles of charcoal finely powdered, or the minute globules of oil in an emulsion ; the second are grouped together under the common name of bacteria. The latter are exceedingly abundant in nature and found in enormous numbers in every putrefying or decaying portion of organic substance, at all times everywhere. There is no longer the least doubt, on the part of those who have studied the subject, but that the minute organisms really cause the decompositions and fermentations which have so long been considered spontaneous in all organic matter, as soon as deprived of life. Milk does not turn sour, meat does not putrefy, wood does not rot, a pile of damp vegetable matter does not heat, from any inherent unstableness of their own composition, or from any direct effects of air or temperature. All these things and all others like them are solely due to the operations of the above-mentioned living organisms. But from the microscopic appearance alone, one is wholly unable to positively discriminate between some of the not living forms and some others known to be living. For instance, the milk-sap of the Euphorbiæ and Chicoraceæ swarms with moving atoms when freshly taken from growing plants. Probably these exceedingly minute particles are globules of oily or resinous matter ; but their color, form and motions so simulate the living organisms known as micrococci or microzymes that I question much whether any microscopist, from appearances alone, would confidently decide whether they were the one or the other. He would first seek to know where found, what the behavior towards chemical reagents, and what the effects of the consistency of containing fluids, as well as what evidence there was of reproduction and death.

Knowing that cells have for their exterior a cellulose membrane in which there are absolutely no perforations large enough to be discovered by the highest and best powers of our microscopes, the idea, if it occurred, that parasitic or other living organisms could gain entrance and dwell imprisoned in such manner was stifled under a presumed theoretical impossibility. This also must have been the case with many other botanists and microscopists, for there is too much evidence to longer doubt that bacteria do sometimes inhabit the cells and tissues of apparently healthy plants !

As an instance, I noticed in 1873, within the swollen tip of a fertile filament of *Ascophora mucedo*, a common black mould on bread, decaying fruits, etc., so many rapidly moving particles that in a note made at the time the field of the microscope was said to have the appearance presented by a swarm of gnats in summer air. An explanation was sought at the time in some peculiar activity of the protoplasm of the cell, but examination was carefully made to ascertain whether or not the cell-wall was with or without perforations. For this purpose nothing better could be selected, for the bladdery structure permitted seeing through it in every direction. With a power of about five hundred diameters, no opening of any kind could be discovered, yet I am now very confident that these active atoms were bacteria, and that the motions exhibited were due to their own life forces. How they gained entrance is left solely to conjecture.

One year after this a similar note was made in regard to the moving particles observed within the cells of the transparent hairs of a healthy plant of *Lophospermum scandens*, a green-house climbing vine. In this case one cell appeared alive with internal motion, while its neighbor, separated only by a thin and quite transparent partition, showed nothing

of the kind. The vine was growing vigorously, a healthy, beautiful specimen, raised from seed and at the time about four feet high.

In numerous instances, I have seen within the cells of leaves and stems of the red foliage plant, known to florists as *Achyranthes Gilsoni*, similar movements ; but the decision is not so confidently pronounced as to the nature of the bodies.

Notwithstanding such cases as these, no special attention was given beyond the passing wonder to the matter ; nor was there much importance attributed to the observations until circumstances occurred which recalled attention to the records.*

Having found that bacteria are active agents in causing disease in plants, especially such as we call blight in the pear, apple, etc., and having endeavored to find out how the organisms gain access to the inner, living tissues, these older observations were naturally remembered and reinvestigated to ascertain more positively the nature of the active particles. Careful search in the healthy tissues of the peer tree proved fruitless, so of many others ; but now and then the phenomenon was observed, and conclusive proof obtained regarding the bacterial character of the moving atoms. They did not simply oscillate and tumble about, but progressively wiggled or darted this way and that, in the field of the microscope. A dilute solution of iodine instantly stopped their motions. They were observed to reproduce themselves, or rather increase in numbers and division.

There were, in the best instances no signs of unhealthfulness in the supporting plants. In the case of hairs consisting of a single row of cells the basal one was found more often tenanted, the others retaining their vitality, though, of course, depending on the basal one for their sustenance.

* Proceedings Am. Asso. for the Adv. of Sc. 1880, p. 583. Tenth Report Illinois Industrial University, p. 18.

During the summer of 1881, a member of my family was twice poisoned upon her arms by *Rhus toxicodendron*. The first time was early in June, and this came from cautiously handling a leafy twig of the plant with gloved hands. Within the following twenty-four hours, while her hands showed no effects of the poison, the forearms, which were only partially covered at the time of holding the twig in her fingers, were manifestly poisoned. The skin became red, swelling ensued, and after the expiration of a day and a night the inflammation rapidly increased until by the forty-eighth hour there was much feverish heat in the affected parts, accompanied with pain, a burning sensation and intolerable itching. Miliary vesicles now appeared, thickly studding the skin, from which during the two to four days much serum was exuded — so much that cloths laid upon the arm were soon wet through. Upon drying, yellowish, gummy matter was left, which sometimes formed during the night a crust-like coating over parts of the inflamed skin. Finally, from eight to ten days after the exposure, the swelling subsided, the exudation ceased and desquamation took place, during which and for a short time thereafter the skin lost its usual sensitiveness to the touch, as if the nerves, too, had suffered.

Upon microscopically examining first the exuding serum, then the contents of the eruptive vesicles, multitudes of very minute spherical or double-spheroid, motile bodies were seen. From the vesicles especially, leucocytes were found, and many of these contained within their integument swarms of the moving particles. All the characteristics of these minute things gave conclusive evidence that they belonged to the group of organisms we call bacteria, or the Schizophytes, and to that division called by Cohn Micrococci.

The second infection, more virulent than the first, took place in

August, and became manifest the next day after a ramble in the woods, but not so far as is known in contact in any way with this poisonous plant.

The microscopical characteristics were throughout such as have been described, and I especially noticed the constant occurrence of the organisms in the white blood-corpuscles, and as this was at the time a new thing to me for any disease, much attention was paid to it.

With these two series of facts before me—the occurrence of bacteria in the tissues of living plants and their presence in the exudations of inflamed surfaces of the human body in consequence of having touched or been in the vicinity of certain plants—it was most natural to connect the two together on the subject. Accordingly, during the month of September, 1881, I gathered some of the freshest, cleanest leaves that could be found at that season of the year of *Rhus toxicodendron*, and carefully washed them in a little pure water. This water being then examined was found to contain several kinds of spores of fungi, and many minute, shining spherules, indistinguishable from the *Micrococci* found in the blood-serum before mentioned. This was followed by an examination of the fresh juice, taken so as to prevent contact with the exterior of the plant, and here, too, minute moving bodies were found in great numbers, though the majority of the latter are really little resinous globules. To complete the proof, it seemed to me desirable to directly apply these organisms from the plant in as pure a state as possible to the skin, and observe their effects. I had supposed myself exempt from the bad effects of the poison and had little fear of the experiment. I therefore carefully cleaned off the outer bark of a fresh stem to remove anything adhering to the exterior, cut the stem across and quickly secured a small amount of the exuding milk-sap, which was at once transferred to about a hundred times its bulk of distilled water. When well mixed, the fluid had only a slight milkiness of appearance and could not have contained, thus diluted, enough of any purely chemical poison known, to have seriously injured the skin or flesh. Still, under the microscope, there appeared many of the moving atoms. I then applied a small amount of the infusion to my arm, having first designated the spot by clipping the little hairs growing upon it. The area covered was not over one-third of an inch in diameter, and the water dried away in about one minute. On awakening the next morning, eighteen hours after the application, the spot was evident from its redness, and there was a slight sensation of heat in the part, both of which symptoms rapidly increased, becoming very evident by the twenty-fourth hour and accompanied with itching. By the forty-eighth hour my arm was much inflamed and somewhat swollen over an area about four inches across. Miliary vesicles arose, but there was very little serum exuded. The inflamed surface increased in size during some six days. To more fully test the infectious nature of the disease I placed a little of the exudation on a remote part of my body, and had the satisfaction of having another place to appease by friction. After about ten days the malady had evidently run its course and gradually abated.

Now I was satisfied that this was very much worse than it would have been upon my hands, except perhaps where the skin was especially thin, as between the fingers; on the palmar surfaces no effect whatever was or, I believe, ever is produced. I was also abundantly satisfied with one experiment, not caring to repeat the process for the sake of comparing results.

Once in midwinter and once in August, 1882, I examined the juice of this poisonous *Rhus* without finding the micrococci, yet after handling

the plant in the first instance my lips and nose plainly enough showed the consequences, probably from a transfer by means of my handkerchief. In the second case, no results have been noticed.

I turn now to another class of poisonous plants, to be more briefly treated because the facts are not so well worked up. I mean the poisonous fungi, known as mushrooms and toadstools.

It certainly is not hard to find undoubted bacteria in many of these as well as other fungi. In crushing the fruit-balls (conceptacles) of the leaf-moulds (Erysiphæ) under a cover-glass, I have frequently seen issuing from the ruptured balls peculiar bacteria which darted hither and yon in the water in which they were immersed. From this statement, my botanical friends may think I have mistaken the minute spores sometimes found in these conceptacles for bacteria, but such is not the case. I have already cited an instance of finding a swarm of micrococci in a filament of a common mould, and it may now be added that they have several times been seen in great numbers in the tissues of the fleshy fungi, while the latter were still young and fresh.

When these poisonous plants are used as food there seems to be two pretty well marked modes of mischievous action, working either singly or combined. In one case the bad results are soon made known by pain and vomitting; in the other case the unfortunate individual perceives nothing wrong for from six to ten or more hours after eating. The first has been ascribed to a peculiar acrid, the second to a narcotic principle, in the mushrooms. The former, though violent, is not nearly so dangerous to life as the slower action of the second. When both act together, or rather one after the other, peril is imminent.

Four persons died from this cause last October in Brazil, Indiana, for an account of which I am indebted to the attending physician, Dr. John T. Price. The poisonous fungi were eaten at noon October 16th, and two died on the 18th, late, and two on the 22d, one about noon, the other at six P. M. The physician says they had towards the last no particular pain, but that decomposition had evidently set in before death.

I relate these terrible accounts to show what serious effects may follow the use of these plants for food, and also to show, by the course of the disease, that there is reason to suspect an organic growth as the cause of the disastrous consequences.

But I have also introduced these unpleasant facts to show what a change must be wrought in these same poisonous fungi by the process of cooking, steeping in vinegar, and the various processes of catsup-making, for it is well known that all sorts of mushrooms are collected and used for this purpose with no ill effects. I once was asked to taste of some supposed mushrooms which had been collected two or three weeks before and placed in strong vinegar, and was assured that they had been eaten with nothing but pleasant remembrances of the fine flavor. Yet these were certainly poisonous when collected.

In conclusion, it may be said that all poisoning from plants cannot be explained by reference to living organisms. We know that garden vegetables, usually innocent and healthful, are at times really poisonous, especially when eaten raw, as we eat radishes, cucumbers, etc. Certain kinds of grasses are commonly said to be poisonous to animals, though the plants of the order *Gramineæ* are so free from any deleterious properties that botanists have long doubted the accuracy of the observations upon which poisonous properties were attributed to them. After a careful perusal of the injuries caused by the famous though misrepresented Upas tree, there does not

seem to me any other theoretical interpretation of the facts so suggestive as this of the action of living organisms tenanting its tissues. Dr. Sternberg, of the National Board of Health, has shown that the minute organisms found in his own saliva, while he was in perfect health, were, by inoculation, deadly poisonous to rabbits. So that we may reason by analogy that a comparatively innocent or even useful organism to a supporting plant may be decidedly harmful when transferred to ourselves.

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Heliopelta Lewenhokii.

In looking over a deposit of weed from Long Island Sound, I found some thirty or more specimens of *H. Lewenhokii*, and, not knowing that they were found in recent gatherings, I wrote to my correspondent, Mr. Charles Stodder, and he says in reply, that "I have never seen a record of *Heliopelta* having been found recent; if you are not mistaken in the genus, it is an important discovery. There is no reason why it should not be found living. Ehrenberg, thirty years and more ago, designated many forms as fossil only, but many of them have since been found in recent deposits." I should be pleased to hear from diatom collectors if they have seen any, and can send a slide for study to any one who will write to me about it.

THOS. CHRISTIAN.

RICHMOND, Va.

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Tadpoles.

About the middle of last May I secured a number of tadpoles to make observations upon the caudal circulation—each individual had only the left eye open. In three days the other appeared, and in about the same time after that the right leg presented itself, since when no other visible changes have occurred in form, size, color, or demeanor.

That solitary undemonstrative leg has hung, swung, floated and waved behind through four warm, dreary, summer months, as useless to all intents as a Chinaman's pigtail, and it still waves—active, vigorous and contented. What will these changeless tadpoles ever come to be? One leg has evoluted, the other involuted; and of the little rotund body it may with propriety be said, that "thereby hangs two tails, one of which will ultimately be spelled without an egotistical vowel. But the question is, how long will the other continue to wag the little tadpole? It is certainly a case of arrest of development—but why? Every condition known has been continuously supplied—food, water, muck, sunlight, shade, warmth, etc., but they are only little tadpoles still.

P. L. HATCH.

MINNEAPOLIS, Minn.

EDITORIAL.

Subscriptions.—Remittances for subscriptions should be made by post-office or express money-orders, by drafts payable in New York, or in registered letters. Money sent in any other way will be at the sender's risk. A receipt will be immediately given for money received by open mail.

The JOURNAL is issued on the 15th day of each month. Subscribers who do not receive their copies at the usual time are requested to inform the Publisher of the fact.

COMMITTEE ON RULED PLATES.—At the meeting of the Section of Histology and Microscopy of the A. A. A. S., at Montreal, after the reading of Prof. W. A. Rogers' paper on ruled lines, a resolution was offered that a committee be appointed to receive ruled plates from different makers that might be offered for examination in accordance with the suggestions made by Prof. Rogers. After some discussion the resolution was carried, but it was afterward decided to postpone the appointment of the committee until some future time.

We regard this as a great step toward the settlement of the question of the practical limit of resolution, independent of any theoretical consid-

erations. If the reader will refer once more to that portion of Prof. Rogers' article printed on page 166, he will understand the nature of the test proposed, and the interests attached to the results of such an examination. We hope, and believe, that at the next meeting of the A. A. A. S. a committee will be appointed in accordance with the suggestions already referred to.

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INTRACELLULAR DIGESTION OF THE LOWER ANIMALS.—In a recent number of *Zoologischer Anzeiger*, El Metschinikoff has an interesting article on this subject, which, however, is largely a criticism of the opinions of another author.

Although it has long been known that some of the lower animals can take nutritive particles into their intestinal cells, the whole question of intracellular digestion has been taken up systematically only during the last few years. The older observations on the intracellular digestion of the lower Metazoa remained isolated and were soon forgotten. Led by the facts of embryology to the assumption that in the original condition the digestive organ must produce a solid, intracellular, digestive parenchyme, the author has studied the digestive process of the lower organisms since the year 1877, and proved that in the turbellaria and cœlenterata (including the sponges) intracellular digestion is general. Taking the results obtained with Protozoa, it was observed that the processes of digestion in some of the lower Metazoa are the same as in the infusoria. Experiments were made with carmine, striated muscle, the yolk of hard-boiled eggs, starch, etc., but these, while they could be readily observed within the animals, were not found to be readily assimilated; but by feeding with natural foods, digestion was easily observed. An excellent organism for such observations is a *Ctenophora*, "in which one can follow the entire process, from beginning to end, *i. e.*, to the formation of the partly crystalline concretions within the vacuoles, in one and the same individual."

This subject can only be studied microscopically. "The physiological-chemical method, however important it appears to be, cannot be used in the investigation of such minute objects as Protozoa, and cells." Fortunately, however, it can be satisfactorily studied with the microscope; and we suggest this as a good, and almost new, field for any one who will undertake the labor of investigation. It requires only patience and careful observation to reach interesting and valuable results. Prof. Leidy has studied the process of digestion among some of the rhizopods, and no one can read his descriptions of it without finding them very interesting.

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MOUNTING HISTOLOGICAL SPECIMENS.—It will probably be a long time before histologists will be agreed as to the best medium for mounting their specimens. Mr. T. Charters White, M. R. C. S., in the course of a very practical article "On the Injection of Specimens for Microscopical Examination," read before the Quekett Club, used these words: "You will, in the subsequent examination of it [the specimen prepared], be able to determine how much is the result of the mounting medium in which I have placed it; for my part, I believe it is entirely due to this that not only the villi but the Lieberkühnian follicles are most clearly shown with the capillary vessels coursing all through and around them; and I must aver that had this specimen been mounted in balsam, or dammar, every detail would have been sacrificed. I consider balsam to be the greatest bane histology has to fight against."

The mounting medium referred to, was glycerin and camphor-water. Other histologists condemn glycerin

above all things. They "cannot use it," "it makes the specimens granular," they have all sorts of objections to it. So they use balsam, and most of the specimens sold are balsam-mounts. Evidently there is something wrong; but the doctors disagree, so how are we to know what to do?

Perhaps many of our readers remember how bitterly Dr. Beale was attacked by many writers, when he first praised glycerin for mounting. He was allowed no quarter, and an impartial reader could only conclude that Dr. Beale had deliberately told a great many untruths about his experience with glycerin, or else that his critics were talking at random, and without giving his methods a fair trial. Undoubtedly the fault was with the latter, for glycerin is now successfully used by many.

The studies of Prof. Abbe, Mr. Stephenson, and a few others, have led to a more accurate knowledge of the influence of mounting media upon the appearance of various objects, so that it is only necessary to know the refractive index of the parts we desire to examine to select the best medium for their demonstration. To be sure, it is quite impracticable to do this, but the researches of these gentlemen have proved that the visibility of objects is determined by the relative refractive indices of the object and the medium in which it is mounted. Hence, to obtain the best results possible with any specimen, it is only necessary to have a series of mounting fluids of different refractive powers, and to try each one of them until the effect is satisfactory.

The fluid described on page 116 fulfills all these requirements for any object that may be chosen, and microscopists and histologists should not be slow to avail themselves of the advantages afforded by this compound.

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TRANSACTIONS OF THE CONNECTICUT ACADEMY OF ARTS AND SCIENCES.—The second parts of Volumes IV and V have both been issued. Among the most notable contributions in the former we notice one by Prof. Verrill on "New England Annelida" which is an historical sketch with annotated lists of the species hitherto recorded, illustrated with nine plates. This number also contains articles on new diptera, with an account of the American species of *Conops;* on *Pimixia* and certain decapod crustacea of the New-England coast.

The second part of the fifth volume, contains about 350 pages, and 33 fine plates, illustrating two articles by Prof. Verrill, one on the Cephalopods of the north-eastern coast of North America, the other a catalogue of the Marine Mollusca added to the Fauna of New England, during the past ten years.

NOTES.

—Mr. Grunow, the maker of the microscope described in the August number, informs us that we were in error in stating that the objective furnished with it is a ¼-inch. It should have been ⅙-inch. The objective sold with the stand is a ⅙-inch, warranted to resolve *Pleurosigma angulatum* in balsam, with central light. Mr. Grunow has also devised a new camera lucida, which he thinks possesses certain advantages over all others. We hope to describe it next month.

—Prof. D. S Kellicott has sent us the following note:—

"I found *Ophrydium versatile* at Round Lake, Petoskey, Mich., in July last. The masses were floating or attached to weeds in shallow water; the size of the globes varied from that of a cherry to four or five inches in diameter. I have recently found small ones at Buffalo."

—The Aurora (Ill.) Microscopical Society, at its annual meeting held September 6th, elected the following officers for the ensuing year: Rev. R. O. Shepperd, D. D., President; Chas. W. Quereau, Vice-President; Dr. John E. Hurlbut, Secretary; Arthur P. Vaughan, Esq., Treasurer; Dr. H. G. Gable, Prof. J. H. Freeman,

and Rev. Dr. Shepperd, Executive Committee.

—We omitted to mention last month, in our report of the meeting of the A. A. A. S., that Prof. A. H. Tuttle read a paper before the Section of Histology and Microscopy on the epidermis of the marsipo-branchs. This was an oversight which we regret.

—At the Montreal meeting Dr. Carl Seiler stated that, after considerable experience in grinding knives for cutting thin sections, he had found that the bevel of the edge should be the same on the two sides, and he explained a device which enabled him to ensure the true bevel without difficulty.

NOTICES OF BOOKS.

The Republic of Mexico in 1882 with Revised and Corrected Map. By Lorenzo Castro. New York: Thompson & Moreau, Printers, No 51 & 53 Maiden Lane, 1882. (8vo., pp. iv and 271.)

This is a very valuable publication, giving a vast amount of useful information concerning the present condition of Mexico, its resources and its productions. It begins with an epitome of the early history of Mexico, and gives an account of its people, its antiquities, its construction, and its form of government. The physical geography and the climate of Mexico are treated at considerable length, and the important mining and agricultural resources enumerated, in which the author finds promise of great future prosperity and wealth to the State. The Republic of Mexico is divided into 27 States, 1 Territory and 1 Federal District. Each of these is described.

A history of mining and a catalogue of the mining districts is given, also a number of itineraries for the benefit of travellers visiting the country either for business or pleasure. A large and well executed map, 35 by 49 inches, is appended.

Annual Report of the Operations of the United States Life-saving Service for the fiscal year ending June 30th, 1881. Washington: Government Printing Office, 1881. (Pp. 428.)

The extent and importance of the Life-saving Service is becoming better appreciated by the public every year. This report enumerates 149 stations along the United States sea-board, of which 6 are on the Pacific coast, besides 34 others on the shores of the Great Lakes. During the year ending June 30th, 1881, there were reported 250 disasters to vessels, having on board 1,878 persons, and only 24 of these were lost, while 66 vessels became total wrecks.

The methods of saving life employed at the stations are vividly set forth in the naratives given of the shipwrecks involving loss of life. The service has attained a high degree of efficiency, and saves not only hundreds of lives but also millions of dollars to commerce every year.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Wanted—To exchange, good slides correctly named, or material for mounting for same.
F. C. SMITH, Bridgeport, Conn.

Wanted, material containing Pleurosigma angulatum, Nitzschia sigmoidia, Frustulia Saxonica and Amphipleura pellucida. Mounted diatoms or material in exchange.
T. CHRISTIAN,
108 Virginia, St., Richmond, Va.

Wanted—Diatomaceous material from New Hampshire containing *Amphipleura Lindheimeri*, in exchange for materials from North of Ireland.
WILLIAM A. FIRTH,
Whiterock, Belfast, Ireland.

Striatella unipuncta, *Rhabdonema Adriaticum*, and other first-class crude material, to exchange for named diatoms and first-class material—prepared and particularly foreign material preferred.
M. A. BOOTH, Longmeadow, Mass.

Mounted crystals for the poloriscope, diatoms (a fine collection), fresh-water algæ foraminifera, in exchange for other well-mounted objects. Send specimens and full value will be returned.
R. HITCHCOCK, 53 Maiden Lane, New York.

Well-mounted sections of Rat's tongue, Rabbit's eye and Cat's muscle, for other well-mounted objects.
F. B. CARTER,
519 Gates Ave., Brooklyn, N. Y.

On receipt of a well-mounted slide, I will send a slide of crystals (for the polarizer), of any of the rare vegetable products which I may have; will send list of same on receipt of postal request.
J. KETCHUM, Jr.,
P. O. Box 877, New York City.

Wanted. — Animal parasites, Ixodes, Acari, etc., either mounted or unmounted. W. A. HYSLOP,
22 Palmerston Place, Edinburg, Scotland.

Unmounted objects, Foraminifera, Spicules, Plant-hairs, Zoophytes, etc., in exchange for other objects, mounted or unmounted.
E. PINCKNEY, Dixon, Ill.

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Grunow's New Camera Lucida.

Mr. J. Grunow of this city has constructed a new camera lucida, which deserves the attention of microscopists.

It was described by the Editor at a recent meeting of the New York Microscopical Society.

The instrument consists of three rectangular, equilateral prisms, so arranged that when placed over the eye-piece with the microscope inclined, which is the most convenient position, a portion of the surface of the work-table of the size of about 12 by 15 inches is projected into the field of view, so as to be distinctly and clearly seen together with the object on the stage.

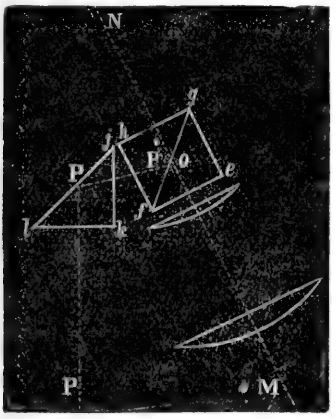

FIG. 43.

The two prisms *e*, *f*, *g*, and *h*, *f*, *g* are cemented together so as to form a cube; the sides *h*, *g*, and *f*, *e*, being parallel. The hypothenuse *f*, *g*, of the prism *h*, *f*, *g*, is silvered, to do away with the blue halo, otherwise peculiar to this form of prism, which would greatly obscure the reflected image.

The silver is removed at the centre of the coating, at the point *o*, so as to leave a clear space about half the diameter of the pupil of the eye. The other prism *l*, *j*, *k*, is placed with the side *j*, *k*, inclined to the cube *h*, *g*, *f*, *e*, at such an angle as may be most desirable.

In viewing the object under observation in the direction of *N*, *M*, through the aperture at *o*, we see the whole field of view, while at the same time the drawing board and pencil are reflected from the side *l*, *j*, of the prism *l*, *j*, *k*, to the silvered surface *f*, *g*, and then reflected to the eye in the direction of *P*, *N*.

Both the pencil point and the object are very clearly seen without any strain upon the eye.

It is in this respect that the maker claims for this camera lucida superiority to any other form.

It can be immediately applied, while the microscope is in an inclined or vertical position, without any change of conditions or loss of time.

The camera is simply slipped over the eye-piece, the paper placed on the table, and the drawing proceeded with.

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Javelle Water for Microscopical Purposes.*

Pearls and Altmann have used Javelle water for the destruction of animal tissues, and thereby have found that the fat withstands the

* Abstract of an article by Dr. F. C. Noll, *Zoologischer Anzeiger*.

action of this water. Without having known of their work I used Javelle water in the preparation of spongillæ.

If silicious sponges are burned or heated in alkali solution the hard parts, spicules, amphidisks etc., fall apart and cannot be prepared in their natural position. In order to obtain them in their natural position in the most convenient way, a portion of the sponge is placed on a slide, covered with a few drops of Javelle water and allowed to stand protected by a watch-glass until all the soft parts are dissolved, which may be in 20–30 minutes with thin pieces. Gemmules require a longer time, perhaps over night, and their contents an dissolved without destruction of the outer membrane.

When all the protoplasm is dissolved the preparation is treated with acetic acid, which removes all obscuring precipitates, then washed with dilute, and finally with absolute alcohol, after which oil of cloves will clear all the still dull-looking gemmules and Canada balsam can be used for mounting. The gemmules of *Spongilla fluviatilis*, *Lieberkühnia* and *contecta*, and of such specimens as grow spread out flat on the under sides of stones, are obtained *in situ* among the spicules, and give with these a complete picture of the form of the sponge. In thicker sponges, as the free growing specimens of *Sp. Lieberkühnia*, the needles remain united although the superficial and cementing substance is dissolved. The layer beneath behaves differently; like the covering of the gemmules it is not destroyed, but it does not become colored black with nitrate of silver like the latter.

Sponges often contain diatoms in their substance. These also are prepared with the sponges as clean as by burning or by boiling in acid. The appearance of the frustules in the Canada balsam is such that I believe the Javelle water would be a very useful reagent for the preparation of diatoms.

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Animal and Vegetable Chlorophyll.

The Editor of the *Botanical Gazette* writes as follows concerning this subject: "To say that one difference between plants and animals is that the food of the former is inorganic and that of the latter organic is hardly a correct statement, for the food of both kinds of organisms is necessarily organic, and its consumption in both cases is attended by a true respiration. A better statement would be that plants, in general, have the power of making their own food, while animals, in general, do not. We recognize that the agent in this case is the granule of protoplasm colored by chlorophyll, just as in the consumption of the prepared food the activity is vested in uncolored protoplasm. The presence, therefore, of chlorophyll granules lies at the very basis of the distinction between plants and animals. It is generally stated that this does not hold universally, as the fungi are devoid of chlorophyll and some animals are known to possess it. The question has now arisen, whether the so-called animal chlorophyll is the same as that of the plant. The results of some investigations upon this subject are given by K. Brandt in the *Popular Science Monthly* for October. The investigations seem to show that, morphologically, the animal chlorophyll is by no means the same as that of the plant for the green bodies which appear in some animals are themselves cells rather than cell-contents, and are nothing else than unicellular plants which have immigrated to animal bodies. They are both morphologically and physiologically distinct from their hosts, for they can live when separated from them and form starch in the sunlight. Thus the distinction is based on the same principle as before, namely, the power of originating, for now we can say not only that plants make their own food and animals do not, but also that plants make their own chlorophyll while animals

do not. But a strange revelation is the relation which these green algæ and other yellow algæ sustain to the animals in which they live. When they are absent the host animal must live like other animals, but when they are present they can prepare food for their host out of inorganic material and the animal can live with the surroundings of a plant. This partnership arrangement between animals and plants upon the lowest confines of the two kingdoms may not seem unlikely now that it is suggested, and reminds one of the sentence in Dr. Gray's *Darwiniana*, which says that "there is a limbo filled with organisms which never rise high enough in the scale to be manifestly either animal or plant, unless it may be said of some of them that they are each in turn, and neither long." Chlorophyll thus holds the same relation to the bodies of animals which it inhabits as it does to plants, and although in the two cases it is morphologically distinct, it is physiologically the same."

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Remarks of Dr. W. B. Carpenter, made at the Dinner of the New York Microscopical Society.

I am, perhaps, the only working microscopist now surviving, who remembers that first development of the achromatic microscope in London, which took place quite independently of what had been attempted by Prof. Amici, in Italy, some time previously, and of what was then being done by MM. Selligues and Chevalier in Paris. A relative of mine who had been in business as a manufacturing optician in Birmingham (where he brought out the kaleidoscope for Sir David Brewster), having removed to the Metropolis, had there become acquainted with Dr. Goring,—a gentleman of considerable scientific attainments and of independent fortune, who was very desirous of promoting the improvement of the microscope by the application of the principal of achromatism to the construction of microscope objectives. In ignorance of the unsuccessful attempt of Prof. Amici (who was then turning his attention to the reflecting construction, as likely to yield better results), and of the contemporaneous labors of Paris opticians, Dr. Goring arranged with Mr. Tulley, who at that time ranked as the best constructor of telescope object-glasses in London, to attempt the construction of a microscope objective; and, working upon his previous lines, Mr. Tulley, at last, succeeded in producing a "telescopic triplet" of about an inch focus, which was immeasurably superior in its performance to the single lenses used as objectives up to that time. I very well remember hearing, some 55 years ago, that when Dr. Goring asked Mr. Tulley what he was to pay him for this glass, Mr. Tulley replied that he could not consider that the time and labor he had expended in its production, would be fairly remunerated at less than 50 guineas,—which Dr. Goring willingly paid him. Encouraged by this success, Mr. Tulley made a second "telescopic triplet" of shorter focus than the first; and this, when superimposed upon the first, raised its power to about a half-inch, with a considerable increase of angular aperture. I saw this combination tried, about the year 1830, in a solar microscope, upon the eye of a fly (which had been previously exhibited with a single lens); and was struck with the excellence of its definition over the entire field, the absence of the broad colored fringes which the non-achromatized lens everywhere showed, especially towards the edge of the image, and the vastly superior brightness of the picture. I believe that it was with this combination that Dr. Goring first saw the striæ on the scale of the *Menelaus*, and the dots on the "battle-dore" scales of the *Lycæna argus*, which became the first

"test-objects" for English achromatics. At that time, our best workers in biological investigation were using — not the compound microscope—but the Wollaston "doublet," which had been greatly improved by its constructors; and, for the highest powers, a "triplet" made on the same plan. It was with these that my late friend Prof. Sharpey, carried out those admirable researches on ciliary movement, which early gained for him a deserved reputation; and that Mr. Slack executed his beautiful dissections of vegetable tissues.

It was at this time—about half a century ago — that the achromatic combinations made by the French opticians, having a magnifying power considerably greater than that of Tulley, were first introduced into London. The power of these combinations was gained by screwing, one upon another, three, or even four pairs, each consisting of a double-convex of crown, and a plano-concave of flint; such as are now supplied with the cheapest French microscopes,—the back pair being of lower power, so as, when used alone, to give about the same amplification as Tulley's inch. This plan gave results for what were then accounted high-powers, which caused it to be forthwith adopted by the London makers Ross, and Powell, who had been previously constructing Wollaston doublets and triplets; and they soon produced objectives of one-fourth or one-sixth inch focus, quite equal to those of French makers, and low powers much superior to theirs.

The next great improvement was the result of the theoretical investigations of Mr. Lister, the father of Prof. Lister (of "anæsthetic surgery" fame), and uncle of the Messrs. Beck. Mr. Lister (whom I well knew), was a gentleman of considerable scientific attainments; who devoted a large amount of time and money to the improvement of the achromatic microscope, and was himself a worker of no mean ability in marine zoölogy. By the application of mathematical analysis to the designing of microscope objectives, he showed that by giving to each pair of the triple combination a special relation to the other pairs, the errors of the whole could be much more completely eliminated than they were by the existing method; and that not only a more perfect correction, but a great enlargement of the angle, could be thus obtained. He endeavored to induce Ross and Powell to begin afresh upon his principle; but not finding them disposed to do so, he took up James Smith, then a mere workman, and furnished him with the means of constructing objectives upon his own designs. Smith soon produced a "quarter" which was so superior to the best of Ross's and Powell's, that the value of Mr. Lister's system was at once universally recognized; and thenceforward, all makers have worked upon it. In connection with James Smith, Mr. Lister also worked out the plan of construction which consisted in resting the "body," of the microscope along its length upon a "limb," instead of supporting it at its base alone; and to his friend Mr. Jackson, a surgeon who had a mechanical turn, we are indebted for the plan of swinging this limb between two side supports, instead of attaching it by a "cradle-joint" on the top of a single pillar, as in the methods then followed by Ross and Powell. Mr. Jackson's improvement originated in this way:— Wishing to build a microscope for himself, he had a difficulty about the cradle-joint, which, before planing-machines came into use, could only be well constructed by a better filer than he knew himself to be. Being, on the other hand, a tolerable turner, he saw that, by swinging his limb on a horizontal axis, he could rest the turned extremities of this upon two side pillars; and thus was originated the "Jackson-Lister model," which was first adopted by

the firm of Smith & Beck (established in London by Mr. Lister's help), and is now, with various modifications of detail, almost universally followed in the construction of all save the smallest and simplest microscopes, as well in this country as in Great Britain.

Being personally cognizant of everything I have now stated to you, I have thought that it might be of interest to you to hear it direct from myself; and have only in conclusion to offer you my cordial thanks for the very kind welcome I have received from you, and my best wishes for the continued success of your Society.

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Abstract of the Address of Professor Albert H. Tuttle.*

It is my esteemed and honorable privilege to preside over the first session of this body held with its present organization and standing as an independent Section of the Association.

In assuming the duties and the honors conferred upon me, I find my mind reverting to the antecedents of this Section and the days of its beginnings. Some, at least, among you, will recall with me the daily gathering of a little company in an out-of-the-way room during the Salem meeting of the American Association in 1869, to which the name of "the Subsection of Microscopy" was first given.

Long shall I remember the sessions of that meeting, half formal, half informal. There we debated (or listened while others debated) gravely whether or no the "nineteenth band" had really been resolved. We triumphed unitedly in the clearness of the demonstration by one of the more expert of our number of the "basket-work" upon *Surirella gemma,—ultima thule* then, to us of test-objects; and some of us, at least, looked for the first time, at and through what was for us the crowning wonder of the day—a Wenham binocular! We discussed there in simple faith the merits and demerits of "that quality in an objective we termed penetration" without a shadow of doubt as to whether we agreed as to what we meant by the expression, or any dream of the latter day scepticism as to the very existence of the "quality" we so earnestly discussed. We listened eagerly while the late Mr. Bicknell described the method by which he made his then unrivalled injections, the open secret of which appeared to be, when all was told, that the way to make good injections (or good anything else) was to take each step intelligently, carefully and correctly; and we gazed with interest, if not with admiration, at a demonstration which some who were present then will perhaps recall, of how a microscope can be made to serve as almost anything that it was not intended to be, if you only modify it sufficiently, and add pieces enough.

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If microscopes were not as numerous then as now, neither were they as easily to be had. In that day he who wanted to buy a microscope had to hunt for it. To-day I had almost said that a man must be rather ingenious to avoid buying half a dozen. Then, he who wished an instrument from a foreign workshop had to make it the subject of a special order; to-day half a dozen importers carry extensive stocks of the instruments most likely to be in demand. Then, as regards American-made microscopes, if a stand was wanted, the buyer looked (and not unwisely) first of all, to a little shop in Philadelphia where labored and still labors—long may he do so—one the thoroughness and fidelity of whose handiwork alone enable him still to hold his own against a score of competitors, who by hand and by steam are putting yearly upon the market countless instruments of every conceivable plan and of all grades of excellence. If one sought

* Delivered before the Section of Histology and Microscopy of the A. A. A. S., at Montreal.

for objectives of the highest character he must perforce seek the atelier in Boston of one who then stood without a rival on the American continent. Though his work is, as I believe, yet to be surpassed, one may look to-day not unprofitably in three or four other directions to find makers of thoroughly excellent objectives; objectives, if you choose, whose available angle of aperture includes, as a still sceptical friend of mine dryly puts it, by far the greater portion of a circumference; while as regards low powers and moderate angles, the market now abounds with excellent American-made objectives.

I would not overlook the fact that there were other makers in this country at that time; men who made excellent stands, and men who made excellent objectives; but I am confident that I do no injustice to others in saying that the two whom I have indicated were the only ones at all widely known.

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Such, as I recall them, were the impressions made upon a young western teacher, himself then a beginner (and even now but little more) of the times and the sessions of the first Subsection of Microscopy of the American Association. The effort made at that time to bring together the workers with our favorite instrument was renewed from year to year at succeeding meetings, the movement gathering strength at Troy, at Indianapolis, at Dubuque, at Hartford, at Detroit, at Buffalo (where the Subsection acquired the dignity of a permanent organization), and at each succeeding meeting, until the result has been obtained which we witness to-day.

While the vastly increased interest manifested in America to-day in the microscope and its use must, of course, be chiefly attributed to that phenomenal movement in biological science which we have been so happy as to witness, and from which we have derived so many and so varied benefits, I think I may justly claim that no small credit should be given to the yearly meetings of the Subsection, with their usual exhibitions and soirées, giving to the people of the various communities in which we have met, notice at least of the existence of such a thing as a microscope, with some scant glimpses of the wonders that it has to show; awakening here and there an interest that has ended in something more than mere curiosity-seeking and amusement; drawing together and uniting those of a common interest; to which last effect may, I think, be at least indirectly traced a result whose future offers great promise of good, the organization of the young and vigorous American Society of Microscopists; an organization in whose power it is to do a great amount of excellent work that could be done by no other means as well.

The influence exerted in one way or another by our half score of sessions would, I think, if it could all be measured, far exceed in value the papers that have been read at them, though these have been neither few nor unimportant.

Such has been our prentice-work; we stand henceforth among our equals as a Section. It would be pleasant here to pass from recollection to prediction, and to spend the remainder of the half-hour in the discussion of great possibilities; we shall do otherwise, however, if we take heed to the pithy suggestion contained in an ancient but excellent volume of practical philosophy (with which I trust that most of you are familiar) concerning boasting and the putting on of armor.

And this the more wisely because another topic of a far different nature presents itself, and, I may almost say, demands attention. Before telling what we intend to do, we are in a certain way called upon to defend our right to be. It is commonly known, I think, that not only in the Standing Committee of last year, but also throughout the membership of the

Association, there have been felt and expressed grave doubts not only of the necessity but also of the propriety of raising the Permanent Subsection of Microscopy to any higher dignity : while the extension and associated limitation of its province which the new name of the Section connotes, though they have so far satisfied these objections as to lead to its establishment, have called forth from others even stronger criticism, as raising to the rank of a distinct department of science that which they had hitherto regarded as holding a far subordinate position. Respect for the candor and the ability of our critics, as well as for their zeal for the wise ordering of the affairs of the Association, would of itself demand that these objections be met and answered. I shall deal with them to the best of my ability ; should my arguments fail to carry conviction, I trust that the weakness will be attributed to the advocate rather than to the cause.

To the question first referred to it has been considered a sufficient answer to urge the fact, which will, I think, be universally conceded, that there is no other instrument of research known to scientific men that has attained so high a degree of development as the microscope ; no other whose parts both mechanical and optical have been the subject of so much prolonged, earnest, and fruitful discussion ; none which has so many and so varied accessory appliances pertaining to it, in relation with its almost endless diversity of uses. Furthermore, this high degree of development calls for a proportional degree of training in the worker.

There is a great amount of study of the instrument itself demanded of him, side by side with an equally great amount of labor that may be regarded as gymnastic in its nature (in which we see the final cause of diatoms for all but cryptogamic botanists, and of ruled plates for all mankind) ; while the various processes by means of which objects of study themselves are brought into a suitable condition for examinatton and preservation call for no little skill and practice. It is urged, therefore, in view of the peculiar character and wide applicability of the instrument in question, and of the extent and arduousness of the discipline that its skilful use requires, that they who have in greater or less measure acquired this discipline are by virtue of that fact drawn together, forming a body of sufficient coherency to be entitled to independent standing as a Section of this Association.

I have endeavored to state the argument in favor of a Section of Microscopy briely but fairly. Love of justice makes me anxious not to understate it, for, as many of you are well aware, I am one of those who have questioned strongly the propriety and wisdom of organizing such a Section ; and I must confess that after an honest endeavor to put the case as strongly as possible in my own mind for those who think otherwise, and to convince myself of the truth, whatever it may be, I am still of the same opinion.

For I do not see what more we can say of Microscopy than that it is a technique ; so elaborate, so complex, that its acquirement in any considerable measure is in itself a valuable discipline, but a technique still. No one feels more strongly than I its fascination ; no one is more alivè to the feeling of sympathy that unites the brotherhood of the tube. I have as lively and practical faith in the value of societies of microscopists and in journals of microscopy, as I have in other technical societies and periodicals. I believe, as I have already said, that they can, under certain circumstances, do a work for science that can be done in no other way as well ; but I cannot see the propriety, in an Association whose aim is first, last, and always the advancement of science, of establishing a Section on a purely technical basis.

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I know that this will be regarded by

some as a false analogy ; and that appeal will be made to the prevalent idea—far too prevalent in my judgment, since it is largely responsible for that diffusion of energy whose practical exponent is the fact that the number of microscopes sold yearly in this country is in proportion to the number of valuable original contributions on microscopic subjects annually produced as over fifty to one —that the skilful microscopist is he who, having a good stand and a number of good objectives which he can handle dexterously, has also a large cabinet of objects, mostly of his own preparation, illustrating as many of the various applications of his instrument as possible ; one who, not specially a botanist, is at home with diatoms and algæ ; not calling himself a zoölogist, has a certain familiarity with Infusoria, Entomostraca and Rotifera ; not claiming to be an histologist, has cut and stained numerous sections of both plants and animals ; neither a geologist nor a mineralogist, has ground, polished, and mounted many sections of rocks and corals ; not a chemist,—but why extend the category ? one, in fine, who, in accordance with a tradition whose history would be full of interest had we but time to trace it, has acquired skill enough and expended brains and labor enough in a dozen fields to have made himself a master workman in any one of them. I confess that I cannot but regard this idea as an idol of the tribe ; to my mind the skilful microscopist is he whose hand has learned all necessary manipulations, whose eye has been trained to nice and quick distinctions, and whose judgment, resting on accumulated experiences can interpret rightly the appearances presented to his eye : and he is most successful who, having chosen a definite field of labor, has worked most diligently there into increase his own or the world's stock of knowledge.

I would not be unmindful of the fact that there are those who, working with the microscope, have entered many fields, and gleaned, nay, reaped richly in them all ; but they are few : neither would I pass unkindly criticism on those who, using the microscope avowedly only as a recreation find pleasure and substantial profit in passing from time to time to fresh fields and pastures new ; I take it however, that the Sections of this Association are organized primarily,if not solely, with the view of bringing together most closely those whose labors have most in common ; and however it may be with objectives, we may be sure that for Sections of this Association not only penetration but definition also is in inverse ratio to angular aperture.

It was therefore the judgment of the Standing Committee (and this judgment was ratified by the vote of the Association at large) that this Section should be established not purely nor indeed chiefly for that technique which the word microscopy implies ; neither should that name stand as the label for a receptacle for communications having only this in common that the objects of investigation are too minute or of too fine a structure to be examined by the naked eye.

They have, instead, established a Section devoted to that department of science whose investigations must be wholly carried on by the aid of the microscope, and to the technique of the instrument as auxiliary to it.

As in the Section of Chemistry papers discussing appliances and methods wereby a more accurate analysis, or a more complex synthesis, may be obtained find place and welcome, or in the Section of Physics discussions of means as well as of results of investigation are gladly received, so here the presentation and description of new apparatus, the discussion of new methods of preparation, of manipulation, or of demonstration find appropriate and ready audience ; but I present as my opinion, which I hope will find echo in your judgment, that papers on subjects pertaining to Mi-

cro-chemistry (if there be such a thing as Micro-chemistry) will best be read to chemists : that papers in what are termed Micro-geology and Micro-petrography will find readiest and most appreciative listeners in the Section of Geology. I would even suggest that a paper on the Entomostraca or the Rotifera, particularly if it deals with the morphology or the systematic position of the form or group in question, will find its normal auditors among the zoölogists in the Section of Biology.

What then remains to us ? I have spoken of that department of science whose investigations must in the nature of things be carried on wholly by the microscope, as being designated by the organic name of the Section as its particular field of labor. I say, that department of science ; knowing that the expression must call forth that adverse criticism to which I have alluded and to which I must now address myself. It has been urged that Histology is in substance but a finer Anatomy ; a dissection made with the eye where the scalpel cannot go ; at best no better than the handmaid of Physiology : and that to dignify it with the rank of a distinct department of science is to give to the servant the honors due to the mistress.

This, I acknowledge, is the traditional view : and this unfortunately, describes only too well the histology that is too often studied and to often taught to-day ; but I am persuaded that the beginnings have already been made of a newer and a greater histology than this ; the leaven that has leavened the whole lump of biology in the last quarter century is working here as elsewhere ; and the resulting recombination of ideas has given us a conception of the significance of the phenomena of cell-life of which a previous generation hardly dreamed.

As a rich amd fertile soil whose yearly harvests pay abundant rental for its tillage may long overlay unsuspected mineral wealth of far greater value, so it often happens that a discovery that proves itself at once of great practical importance, may remain for a long time with its philosophical significance unrecognized.

The results of that inquiry into the structure of the organs of living beings which the immortal discoveries and inventions of Lister and his contemporaries first made possible, were found to have so much practical value to the physiologist that they were at once appropriated to his use.

This analysis did not at first go beyond an idea of fibres, cells and membranes ; it did not seek and only vaguely dreamed of any kinship between them ; later, when, their essential affinity was at first surmised and then demonstrated, the fact was, save by a few, regarded as of secondary importance to what had now come to be commonly known as Physiological Anatomy.

To-day, however, the situation is changing rapidly. The conception long since advanced by one of the greatest of living thinkers that the continous processes of adjustment of relation which make up all we know of life are the resultant or algebraic sum of the activities of the structural elements which make up the living being, and that organs and organisms alike must be regarded as the consequence of the integration of countless cells or nucleated corpuscles, is yearly gaining wider acceptance. Some one has said that the doctrine of the survival of the fittest is the equator of the sphere of biology : may I express the opinion that the conception to which I have referred will one day be for physiologists at least its prime meridian ? However this may be, this conception, it will be readly admitted, has greatly enhanced the significance and the dignity of the study of cell-life.

There is another and even more important relation of Histology to Biology that is very apt to be overlooked by those that regard it as adequately described by the name of Physiological Anatomy. I refer to its relation

to Morphology, and its bearing on questions of affinity and classification. * * * * * *

The claim of histology to rank as a distinct department of science might well be allowed to rest upon the amount and the nature of its increased importance, both physiological and morphological, that I have indicated; there is another consideration in its favor, however, that I regard as far weightier. I have hitherto spoken of tissues and their activities as related to the functions and the structure of organs and organisms. I would now call your attention to the value of the study of cell-life considered in itself.

We have most of us had our eyes opened for some time to the magnitude and the significance of the struggle for existence that goes on at all times between organisms; it is only recently, however, that our attention has been definitely called to the struggle of parts within the organism, and to the probable truth that every organ is where it is and what is through a long series of adaptations to its environment. And this analysis must be carried still farther: for as the body is built up of its organs, so, as I have already said, is each organ the result of the integration of its cellular elements. The great law of biology that gives order and system elsewhere leaves no chaos here; and our histology is not complete until every tissue and every cell has been studied in its light.

Here, then, is our province. Is it not ample enough? It embraces the study of cell-life, in all its bearings, in plant and animal alike. Since sound fundamental ideas of the laws which govern cell-life can only be obtained by prolonged and careful study of those plants and animals which consist but of single cells, or of undifferentiated social aggregates of cells, I claim for hearing here all papers relating to the Protozoa and the Protophyta, including particulary the ferment-organisms on account of their frequent pathogenetic function. Before us come, of course, all papers dealing with cell-life in the higher organisms; papers alike upon the morphology of cells and on higher morphological questions treated by histological methods; papers alike on the development of cells and on the structure and significance of embryonic layers and tissues. The newer histology is still the helpmeet if not the servant of physiology; while large place will be given here to questions of cellular teratology—for what is pathological histology other than this?

Lastly, but not leastly, we shall welcome here all papers and discussions calculated to help us either to better microscopes, or to a wiser use of those that we now have.

Composition and Microscopical Structure of Coal.

BY PROFESSOR P. F. REINSCH.*

Among the various branches of Natural Science the history of the formation of the surface of our planet claims a large amount of general interest. It is of interest to know the life and the phases of life of any great individual; and much more the history of the body of our planet. It cannot be denied that, to a certain degree, tendencies to evolution do exist in the various phases of transmutation which the matter of the earth has undergone; that relations between the phases following one another do exist, just as in organized bodies—in one word, in the phases of transmutation of our planet we see development. * * *

The space intervening between the formation of primitive gneiss and the present time may properly be styled the phase of organic life in the life-history of the earth. Organic life becomes an important factor in the transmutations and formations on the

* Read before the Victoria (Philosophical) Institute, London, Eng. The name "carbon coal" in this article refers to coal of the carboniferous period.

terrestrial surface. Layers of limestone and coal, sometimes of immense extension both in the vertical and in the horizontal direction, are produced for the most part by the aid of organisms of both animal and vegetable nature, commonly of microscopic size. The history of the formation of these minerals, produced exclusively by the aid of vegetable life, as well as the question about the true nature of them, has not yet come to any definite conclusion. The formation of these minerals fills up an important chapter of the life-history of the earth. A large amount of carbonic acid, in devonian and silurian times, diffused in the atmosphere, was withdrawn from it under the influence and by the aid of a most energetic development of vegetable life; and thus produced the conditions of existence for higher animal life. I may be permitted briefly to allude to the various views and experiences about this mineral, so important for modern life, and so remarkable both from its microscopical structure and its chemical composition. The writers on natural history of ancient times do not make any mention of it. The first writer who makes mention of coal, under the name of combustible fossils, is Agricola, the founder of mineralogy. * * * * *

The first observation of the vegetable structure to be seen in coal was published in that year. The first observer, Hutton, says that in each of the three common sorts of coal in England, anthracite, slaty, and cannel coal, more or less vegetable structure can be seen. This observation has been confirmed by Göppert, and he mentions a new method of examination, by burning off the coal and determining the structure of the skeleton of ash which is left.

From the first observations of Hutton and Göppert until the present time the general knowledge of the microscopical structure of coal has been increasing. Through observations of Bailey, Dawson, Quekett, Newton, new bodies, unknown before as constituents of coal, have been added to the bodies of reticular structure previously known. The knowledge of the flora of the higher plants of the carbon period has been advanced through the excellent works of Göppert, Andrae, Weiss, and Williamson, but the knowledge of the microscopical structure, and of the various constituents, of coal did not make equal progress. The principal reason of the difficulty of penetrating into the darkness of the coal substance, and getting clear observation of the microscopical structure and composition was this, that it is next to impossible to obtain, as can be done in the case of most other mineral substances, microscopical sections of such a degree of transparency that all bodies composing the substance become discernible. Coal seems to have opposed obstinate resistance to all efforts; it has resisted the most powerful solvent of the structure of vegetable tissues, a mixture of chlorate of potash and nitric acid. There has been no doubt that the bodies seen at first by Hutton arise from plants; but the question was, if there were in those bodies in the coal any things analagous to our recent vegetable tissues, and, in case these bodies were remains of plants, if there were any identity with the cellular tissue of those plants, from which the coal could have originated. Observations on peculiar bodies of constant form and more transparent nature, claimed as belonging to the class of spores, have been the last important contributions to the knowledge of the microscopical constitution of coal. Dawson makes mention of numerous spores inclosed in the torbanite of Scotland and in the tasmanite of Australia, "little disks of dirtyish yellow color," and found in many coals and slates, but not in so great numbers. Observations have been made by Newton on bodies in the coal of peculiar form, and very pro-

bably composed of the same substance as the bodies held to be spores in the torbanite. There is no doubt that in these observations first notice is given of some forms of these essential constituents of coal which I described in detail in the first division in my book on the microscopical structure of coal * * * *

If we make a careful examination under a low magnifying power of the vertical fracture of a piece of common and normally developed carbon coal, the first thing we observe is a remarkable homogeneousness and regularity in the structure of the substance in one and the same direction, viz., the direction of the bed. Among 100 pieces from various localities there would not be found four or five cases of differing structure. We obtain the same result if we examine any coal bed in the mines at a little distance. We observe in the vertical fracture symmetrical stripes, running in the same direction, and belonging in most cases to one and the same substance. The thickness of these stripes is found to be nearly uniform in a piece of larger size, but very often the substance is found gradually to decrease in quantity in the bed. At the distance of some metres the substance dwindles and ultimately disappears. * * * * * *

If we examine with higher power (200 to 300) these constituents of coal, in any good and transparent microscopic section of coal, we see clearly a great uniformity and constancy in the microscopical structure of the various substances discernible even with the naked eye.

A.—The dark substance with conchoidal fracture, and nonfilamentous structure, making the principal constituent of coal (over 30 per cent), is composed of a net-work of very numerous extremely delicate ramifications, the larger branches of which are connected with larger and thicker stems of more compact and semipellucid substance running along the direction of the bed. In a section of at least $\frac{1}{200}$ mm. thickness, the single meshes and branchlets appear distinctly limited and composed of nearly homogeneous substance. The tint is a deep reddish-purple. The spaces between the meshes are colorless and filled with mineral substance more or less soluble in hydrochloric acid, and of low polarizing power. Some variety is observable in the structure of the larger stems: they are composed either of distinctly separated, irregular incrassated filaments, or of longitudinal bodies with perforated and reticular structure.

The nodules inclosed in this constituent of coal appear, when viewed in a thin and polished section, to be composed of semi-transparent, yellowish, polarizing substance, either regularly arranged round a centre or forming bodies of dendritic and leaf-like shape with radial structure. Bodies of regular and globular shape show the dark variable or revolving cross of polarisation very regularly. This substance, containing from 10 to 30 per cent of combustible matter, is found constantly in some marked varieties distinguished in color, regular shape, size, and structure.

B.—The dark substance with filamentous structure appears in any microscopical section to be composed of filaments, running exactly in the direction of the coal bed. The filaments connected with hair-like ramifications, and arise from larger stems composed of the same substance. The finest ramifications, attached closely together in the typical substances, are found separated through small spaces with interposed lamellæ of transparent mineral substance. In a great many coal beds are found, interspersed between the filaments, numerous corpuscles of substances belonging to other constituents of coal either isolated or connected. From the nature of the substance these corpuscles cannot be constituents of the filamentous substance, both because of their irregular occur-

rence and their diversity in form.

C.—The so-called soot shows both in vertical and horizontal section no essential difference. The substance is found in any good section, forming reticular and angular tissues always composed of the same untransparent substance, but extremely variable in size and shape of the meshes. In a single microscopical section we can meet in many places with four or five tissues, different in size and shape of the meshes, and filling up a space of at most $\frac{1}{10}$ mm. in diameter, so closely attached that we find no traces of any difference between two neighbouring particles. From the mode of succession and of the connection of the different tissues the experienced observer of living vegetable tissues is compelled to admit that all those different tissues must have been in a state of genetical and morphological connection, and to deny any fragmentary composition of the substance. The true nature of the substance is clearly seen in the case of immediate contact with various adjacent substances.

The grammitoid substance* is found pentrating in a filamentous form. The filaments are spread out within the zone of contact, and all through the substance, without becoming mixed up with it, and the substance is easy to distinguish, from its angular structure and from the fact that it is still untransparent even in sections of $\frac{1}{150}$–$\frac{1}{200}$ mm. thickness. Very often the reticular and angular tissue in part is found transmuted into a compact and structureless mass of sulphuret of iron. The nature of the substance is as dark as the substance itself.

Neither in the anatomical structure of those vascular plants the woody fibre of which might have furnished the material (calamites and other vascular cryptogams growing on the borders and the surface of the carbon continent) nor in plants of our recent flora, do we meet with analogies in structure and general morphological nature. In most cases, and in good microscopical sections, after having carefully compared a great many specimens in respect to the morphological relations and the relations of other substances which are without doubt organic, we arrive at the conclusion that the grammitoid substance must be a peculiar one produced by some process independent of active mechanical forces and mechanical accumulation, and that the present morphological condition in which we meet with the substance in the coal bed must be, in most cases, the same which prevailed during the time of the organic life of the substance. * * * * * * * * *

Small beds of grammitoid substance from 1 to 3 centimetres in height are met with in each larger coal bed. * * * * D.—The reddish brown, hard, slaty matter, which is an essential constituent of coal, in vertical and horizontal sections proves to be composed mostly of a great many substances, very different in color, size, shape, and histological character. There are observed over twenty different bodies, each one of these bodies bearing the character of a typical being, with constant marks of structure and size. All these bodies are distinguished from the other constituents of coal by an intensely bright color ranging from brilliant gold-yellow to dark purple. The histological structure is, as far as can be seen, invariable for the single types, and any specimen found in the layers of other substances can easily be indentified. Most of these bodies are widely dispersed throughout the carbon coal, though their absolute amount is less (5 to 7 per cent). In any microscopical section of carbon coal we can meet with isolated specimens. Some of these bodies are found through all coal beds of the productive carbon, sometimes inclosed in the interspersed layers of

* I described the various varieties of this substance in my book on coal under the collective name "Grammitoid substances."

clastic materials (clayish slates and sandstones). There are found three constant types of these bodies:—

a. Flat or subcylindrical bodies of filamentous and ramified structure.

b. Flat or subcylindrical bodies, forming simply filaments.

c. Flat, rounded, and various shaped bodies of granulated structure.

Between these three types are found forms containing filaments, connected with granulated bodies, others with bodies of fibrous and granulated structure. The latter bodies are commonly found with regular limited circumference and equal extension in the three dimensions, other bodies with irregular limited circumference and prepondarant longitudinal extension. The bodies of some of these types exhibit, from their constancy, the qualities of organic individuals.

Dispersed through all coal beds of the carbon, in free and isolated state, specimens are found of these curious bodies, the size of which does not vary much for the single forms. The largest form is found from 2 to 3 millimetres in length, the minutest 0.20 millimetre diameter. All these bodies belonging to this group of constituents of coal exhibit considerable regularity in their histological elements. These elements, granules and fibres, generally of the same size and shape, appear constantly composed of the same non-polarizing substance. Globular bodies of more homogeneous nature, and generally of the same diameter, are constantly found as accessory constituents to the body of the substance.

These bodies are not unfrequently found separated from the body from which they arose; doubtless they must have been in some genetical connection, as the same bodies are observed still connected with it, and some of the globules evidently not in a developed state.

A great many of these bodies exhibit remarkable transmutations, effected in the structure, as results of immediate contact with the yellowish semi-transparent substance of the nodules, enclosed in the principal constituent of the coal. The regular radial position of the molecules of the spheres of this substance becomes altered: some particles of the body, being in contact with, and partly histological elements of, the latter become separated from the whole body; and particles mixed up with and enveloped in the polarizing yellowish substance are found inside the transmuted spheres. Bodies of filamentous and fibrous structure in contact with the spheres are turned off from their regular position; the zone of contact of the substance is dispersed into filaments and fibres, still distinguishable from the polarizing substance; bodies of granular structure are resolved into cellular granules of the same size and shape, the latter sometimes separated from the whole body, and enveloped in the polarizing substance.

Within the layers of the various substances of the carbon coal bed are found layers of clastic mineral substance from microscopic size up to several centimetres in height. These clastic microbeds constantly contain fragments derived from the substances of those microbeds being in immediate contact. In many cases complete and connected groups are still seen in immediate connection with the substance from which they arose, and enclosed within the clastic substance. In many cases the histological structure and the general feature of the substance, in this isolated state, can be seen very much more clearly than is possible in an accumulated state in the pure microbed of the substance.

Some of these microbeds of clastic substance contain very well-preserved fragments of cellular and vascular plants. Some varieties of spores of vascular cryptogams of uniform size and shape are found mixed up with

fragments of well-preserved cellular tissue, and with substances belonging to neighbouring layers of the coal bed.

The general results of these new examinations of the microscopical structure of carbon coal are as follow:—

1. The coal of carbon is composed of substances different in histological structure and chemical constitution.

2. The single constituents of coal exhibit absolutely identical histological and morphological qualities.

3. The constituents are found either in an unmixed state, forming small beds (microbeds), or mixed up together.

4. The histological elements, in the case of immediate contact, still remain unaltered, and, in the zone of contact, still distinguishable.

5. In these cases peculiar transmutations are observed in the structure of two different substances, being in immediate contact (phenomena of contact), transmutations extending to histological structure and to morphological qualities.

6. The position and direction of all corpuscles of longitudinal and flat extension inclosed in the coal bed, is invariably the same, viz., the principal direction of the coal bed.

7. The histological structure of the constituents of coal exhibits a great variety, bnt is found to be of most constant character for one and the same form.

8. The juxtaposition of the histological elements is as follows:—

a. Longitudinally ramified.
b. Reticularly ramified.
c. Symmetrically ramified.
d. Undivided.
e. Radial-spherical.
f. Cylindrical.
g. Spherical.

Purely reticular disposition is found with one homogeneous and opaque substance (grammitoid).

9. The size and color exhibit in all substances great uniformity.

10. The variation in the structure and composition of the various coal beds is found to increase largely in microscopical detail.

11. If we are unable to allow the character of organic beings (not individuals) to a great many of these bodies, composed of organic substance, the latter cannot be derived simply as fragmentary particles from other vegetable beings, nor from the products of the process of decomposition of vegetable substances.

12. No distinct rule is observed in the succession of the various substances in the coal beds, but great varieties of the qualities of the microbeds, and we cannot observe any proportional relation in the distribution of the various substances within the coal bed.

EDITORIAL.

Subscriptions.—Remittances for subscriptions should be made by post-office or express money-orders, by drafts payable in New York, or in registered letters. Money sent in any other way will be at the sender's risk. A receipt will be immediately given for money received by open mail.

The JOURNAL is issued on the 15th day of each month. Subscribers who do not receive their copies at the usual time are requested to inform the Publisher of the fact.

THE CURRENT VOLUME.—The subscription-list of the JOURNAL has increased so much during the present year that we feel justified in announcing an increase of price for complete sets of volume III. All future subscriptions at $1.00 for 1882 must begin with the April number, or later. The price of a complete set is now fixed at $2.00 net. We hoped to wait until the completion of the volume before making this announcement, but our stock of back numbers is getting so small that we fear it will be entirely exhausted by the end of the year.

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THE PROBLEM OF LIFE.—No one can foresee the ultimate result of the simplest observation in science. As the train of thought aroused by the fall of an apple led to the conception of

a universal force of gravity, so, from the slightest hint, the biologist may yet be able to formulate a theory of life. For this reason, the article on page 191 on life and death in the animal world, although it is purely philosophical and speculative, at the present time possesses an interest for even the most realistic student. It may be said, and truly, that such articles only tend to reveal to us the limitations of our knowledge of this problem. At the most they are but ingenious hypotheses, or futile attempts, to explain what still remains as much a mystery as ever. Yet how often it has happened in the experience of the past, that the most brilliant and far-reaching discoveries have suddely sprung forth out of an ignorance as dense as this!

When we think of the advance in knowledge since the days of science in its infancy, or even since the begining of the present century, is any one so bold as to attempt to define the bounds of finite knowledge? Dare we declare that even the mystery of life is beyond and above human comprehension?

If not, then there is a legitimate field for speculation opened by such contributions as those of Bütschli and Cholodkowsky, which the student should not despise.

Already chemists have studied this subject, and many of the complex compounds produced in the animal body have been synthetically formed in the laboratory. Such investigations indeed, do not throw light upon the processes of cell-nutrition and metastasis, but, by revealing the molecular structure of the compounds, and indicating the different possible ways in which the particular groupings of its constituent atoms can be brought about, they have opened a path toward a more intimate knowledge of the processes within the cells.

After many years, the old idea of a specific vital force antagonistic to the ordinary chemistry has been eliminated from science. We now study the chemistry of living things unhampered by false ideas of life. We no longer believe in a special chemistry of life, but rather we regard life as sustained by, if not a direct result of, chemic forces—by which we mean the interaction of ultimate atoms.

Nevertheless, the artificial synthesis of organic compounds by no means justifies the assumption that the processes of life can be produced, or even imitated, in the laboratory. They only lead, as we have said, to a knowledge of the processes in the chemical laboratories of animals and plants — which are the cells. But that we shall ever succeed in balancing the opposing atomic forces of the universe so that, by their continuous and mutual intraction, chemical changes will go on indefinately as in the living cell, is not to be even dreamed of.

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ARTIFICIAL CELLS.—In connection with the preceding article we should not omit a reference to experiments which have attracted notice from time to time, in regard to the artificial production of cells, not, indeed of living cells, but of cells so nearly like those which live as to be indistinguishable from them in appearance and visible structure. They are produced by the slow chemical action of two salts which, when they react together, form an insoluble compound. It is said that the artificial cells thus produced are enclosed by a true membrane, which allows of free passage to liquids, and their interior granulations are arranged in a regular order, as in living cells. So striking is the resemblance between them and living structures that it has even been suggested that they may have been produced accidentally in the history of the world, and their forms been preserved in the rocks, and are now described as fossil remains of past life.

What seems of most importance in regard to these inorganic forms is

that they indicate that the form and structure of organized cells may not entirely depend upon the life-force within them, but may be also influenced by the forces of molecular physics with which we are familiar. In other words, it may be said that a typical cell is spherical because the natural tendency of matter is to aggregate into spherical masses, and not because the forces of life tend to give it that shape—which we know from observation is not the case.

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THE VITALITY OF GERMS.—A note ont his subject by A. Certes, in the *Bulletin de la Société Zoölogique* recounts an interesting experiment carried out by the author. In March, 1878, he received from Algeria some salt water containing algæ, infusoria, and some larvæ. This was allowed to evaporate in the sun and the sediment was carefully collected and kept three years—until April, 1881 The sediment was then placed in boiled and filtered rain-water, and care was taken to exclude germs. Ciliated infusoria and flagellates soon appeared, and about the beginning of June there were found some larvæ, at first microscopic. They multiplied and increased in size and soon transformed into an animalcule of about one centimetre in length, which was recognized as *Artemia salina*.

The Sahel of Algeria is overlooked by a small mountain, the Boudzarea, on the summit of which remain the trenches of an old Turkish fort. In 1877 the drouth was excessive. After the first rains the author climbed the mountain and, in the same trench where he had found it eight months before, he found an abundance of *Blepharisma lateritia*, a ciliated infusorium. It had, either as an animalcule or as germs or cysts, withstood a torrid heat for several months.

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THE INFUSORIA.—The sixth and last part of the "Manual of the Infusoria" by Mr. W. Saville Kent has been issued, and as the work is now complete we take pleasure in congratulating both author and publisher.

The "Manual of the Infusoria" will be an enduring monument to the ability and persistent labor of its illustrious author. In the few brief notices we have given from time to time, we have not presumed to review any portion of it, and now that it is complete we can only express our sincere appreciation of its value as a standard work on the infusoria, and also of the scientific methods of investigation and research which throughout have characterized the observations of the author.

It would be remarkable if no errors of interpretation have crept into such a large and comprehensive work. But such as there are can only be eliminated by the results of future study. Probably the author's views concerning the animal nature of the Myxomycetes will be regarded by most readers as erroneous, and the argument in the admirable chapter designed to prove the protozoic nature of sponges will not be universally accepted by the followers of Häckel; although they seem convincing enough. However, we have no words of presumptuous criticism to offer here. For more than twenty years Pritchard's great work on the Infusoria has been essential to the student of minute forms of life. When Pritchard wrote, almost nothing was known of the life-histories of the organisms he described. Mr. Kent has availed himself of the vast stores of knowledge which have accumulated during that long period, to which he has contributed a goodly share himself. His classification is, therefore, a great improvement upon earlier ones, and perhaps it is as good as our present knowledge renders possible.

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TRICHINA SPIRALIS.—P. Mégnin has contributed an article to the Société Zoologique de France on "Minute Agamous Encysted Helminthes which may be confounded with

Trichina Spiralis," which is printed in the *Bulletin* and illustrated with three plates. The worms figured are *Trichina spiralis*, *Spiroptera strumosa*, Rud., *S. Abbreviata*, Rud., *Dispharagus*——? Comb., *Spiroptera clausa*, Rud., *Spiroptera*——? These are also described in the text.

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PROF. TUTTLE'S ADDRESS. — Instead of giving a short abstract of this address, as we at first intended, we found it necessary to print nearly the whole of it, in order to do full justice to the views of its able author. Prof. Tuttle very modestly asks that any weakness in his arguments be attributed to himself, rather than to the cause. Taking one view of the subject, the view so well maintained by Prof. Tuttle, it must be admitted that the establishment of an independent section of microscopy seems to confer upon microscopy the dignity of a science which it scarcely deserves. Yet there are other considerations which, it seems to us, fully justify the formation of the section. Certain subjects will always come before the Association which could not be appropriately presented before any of the other sections. As an instance of this, the address of Dr. Carpenter, published last month. Many subjects pertaining to the microscope belong as well to the physical and biological sections; but as both of those sections have as much as they can do already, it is well to afford an opportunity for the presentation of such subjects before a special section.

On the whole, we think the establishment of the section of "Histology and Microscopy" was a commendable action on the part of the Standing Committee.

NOTES.

—According to Dr. T. J. Stuart the following method of mounting gizzards of insects is a good one. Kill the insect, a cricket is mentioned particularly, with benzine, cut off the extreme tail and pull off the head which will bring out the intestine with the pyloric teeth. Cut off the intestine and digest it half an hour in solution of caustic potash. Wash it well by shaking it up with water to detach the muscular coat and the tracheæ; then slit it up and mount in balsam by the carbolic acid process. The so-called gizzards of insects if well prepared make beautiful objects, and we are surprised that they are not more frequently seen in cabinets.

—The third number of the *Journal of the Postal Microscopical Society* (London) contains much interesting reading. There is an article on the adulteration of coffee, an exceptionally good article describing the structure and habits of spiders, a second paper on preparing foraminifera, which treats of the methods of obtaining the fossil forms, and some very good notes by Mr, Tuffin West, besides other matter, This number has five excellent plates.

—The seventh edition of Messrs. Bausch and Lomb's "Price-list of Microscopes, Objectives and Accessories" is a neat pamphlet of 48 pages well printed and fully illustrated with excellent woodcuts. All their microscopes except the new "Professional" stand are figured, and that is fully described. The microscopes made by this firm are well disigned and carefully constructed, and are deservedly popular.

—According to Herr Chr. Stunbuch the presence of any particular kind of grain in a mixture is not to be recognized by measurement of the starch-granules. It is generally necessary to examine the debris of tissues contained in the farina, such as the pericarp and the albumen, the gluten cells, etc. This examination is very difficult for the reason that the debris is lost in the great excess of starch and albumenous matters. Levigation only imperfectly separates the latter, so the author proposes to dissolve them chemically. For this purpose the farina is first treated, at 50°—60°, with a solution of limpid malt, then washed several times with water and then digested for some time with a 1 per cent. solution of caustic soda et 40°—50°. The debris of tissues accumulates in the insoluble portion, and may be easily recognized.

—The Scovill Manufacturing Company have devised an admirable apparatus for photographing microscopic objects. It is

a complete outfit, including a lantern for illuminating objects, with a ruby glass side which affords a light by which plates may be developed, a long-bellows camera with a conical tube to receive the microscope body, a dozen plates for negatives and a dozen for lantern transparencies. The price of the outfit is $18.00.

—A great deal has been written of late in the English journals about softening coal by soaking it in potash previous to cutting sections with a knife, because the "Micrographic Dictionary" said it could be done. It is not improbable that some very soft coals can be readily cut after soaking in potash, but it is astonishing how many persons have tried to soften lumps of pure carbon—solid anthracite, in fact—by soaking it in potash!

—Now that the method of mounting insect preparations without pressure is becoming popular—we hope it will result in throwing the flattened and distorted objects now so common in the stores entirely out of the market—a few words about the illumination of such objects may be of value.

Although the objects are mounted as transparent objects, there will always be some parts which are more or less opaque, especially in the larger specimens. We have found much benefit from the use of a condensing lens above, as for an opaque object, at the same time throwing the light in from below. We have a specimen of *Cimex*, mounted in balsam by the carbolic acid process, which affords a good illustration of the utility of this double illumination, and we call attention to it with confidence that others will find it as useful as ourselves.

MICROSCOPICAL SOCIETIES

At a meeting of the NEW YORK Society, held october 6th, which was the first meeting after the summer vacation, there was a very large attendance and a large number of fine objects were exhibited. The special subject of discussion was summer experiences in collecting, and several communications of interest were made. President Braman, Mr. A. D. Balen, Mr. Hyatt and others taking part in the discussion.

Mr. Hitchcock read a letter from Dr. W. B. Carpenter, who was expected to be present at this meeting, explaining the cause of his absence. The Board of Managers afterward resolved to invite Dr. Carpenter to address the Society at a special meeting on the subject of the *Eozoön Canadense*

A special meeting was accordingly held on Tuesday evening, October 10th, when Dr. Carpenter gave a summary of his investigations on the structure of the Eozoön, and exhibited specimens under microscopes, and some photographs of the structure, which were very instructive. We will not attempt to give a full report of this admirable presentation of a subject very difficult to explain without the illustrative specimens. It may be said, however, that Dr. Carpenter has lately discarded the idea that the so-called nummuline, or minutely tubular, layer is part of the original structure of the shell, although by others it is still held to be the means of communication between the cavities and the system of ramifying canals in the intermediate limestone. He is more than ever convinced that the canal system is not to be accounted for by any process of mineralization.

After adjournment the Society again assembled at Delmonico's, on Fifth Avenue where a dinner was given in honor of Dr. Carpenter's visit, which was enjoyable in every respect.

After dinner President Braman arose and with a few introductory remarks began the speech-making and proposed a toast to the guest of the evening in the following well-chosen words:—

"To the clearest thought and truest feeling, the minute is as grand and instructive as is the vast; for force and law are as imperially active there as in the system of planets and suns.

"The minute is, as it were, the heart of nature. A benediction, therefore, on that instrument which, by disclosing the minute, brings us near to nature's heart! and long life to him who has shown to the world the preeminent value of the microscope in scientific investigation, and has lucidly described so many of its marvellous revelations! The microscope and its revelations: — Dr. William B. Carpenter."

Dr. Carpenter's response is printed on page 203. Following this Mr. A. A. Julien responded to "The Royal Microscopical Society of London. The society which leads the world in the branch of study which it represents." Mr. J. D. Hyatt proposed a toast to Prof. E. Abbe, to which Mr. Hitchcock was called upon to espond. Prof. Samuel Lockwood was

invited to speak, and he gave some interesting reminiscences of his experience in this city years ago, when he was instructed to conduct certain investigations for the Academy of Sciences, for which he was unable to obtain a suitable microscope. Mr. William Wales responded to "The New York Microscopical Society," and made a stirring speech. Prof. E. H. Day was called upon, and he made some excellent remarks on the subject of education. Mr. C. F. Cox spoke in a very pleasing manner on the proper aims and possibilities of microscopical and other scientific societies.

We take pleasure in saying that the entire evening was most pleasantly and profitably spent.

NOTICES OF BOOKS.

Guides for Science-teaching. No. VII. Worms and Crustaceæ. By Alpheus Hyatt. Boston: Ginn, Heath & Co., 1882. (Pamphlet, pp. 68, with plates. Price, 35c.)

This is one of the "Guides for Science-teaching" published for the Boston Society of Natural History, "designed to supplement lectures given to the teachers of the public schools of Boston." The author of this book has succeeded in giving the information that teachers will find most valuable in their work. It is well illustrated, and the descriptions are very easily understood.

The earth-worm is first described, and a short account of its habits is given. The lobster is taken as a representative of the crustacea, and considerable space is given to a description of its parts. The general reader who takes up this book will surely be surprised at the interest attached to the careful examination of a lobster. Other crustacea are also described, all of them readily obtained. The teacher who, with the aid of such a book, fails to interest the scholars in natural history is certainly not worthy of the calling.

A Bibliography of the Microscope and Micrographic Studies, being a catalogue of books and papers in the library of Julien Deby, fellow of the Royal Microscopical Society; member of the Quekett Microscopical Club; late Vice-President of the Société Belge de Microscopie, etc. Part III. The Diatomaceæ compiled with the Co-operation of Frederic Kitton, Hon. F. R. M. S. London: Printed for Julien Deby, by David Bogue, 3 St. Martin's Place, W. C. 1882. (Small 4° pp. 68.)

This is an elegant and very useful publication, printed by the author for private distribution. It embraces besides a list of books and pamphlets relating to the diatoms, as well as of collections, a chronological index which cannot fail to be of great value to the student. The list of books includes not only those in the author's library, but also many others distinguished by an asterisk as desiderata; which make the bibliography much more complete.

The first and second parts of this work, "which will contain similar lists of the works relating to the microscope proper, the Protozoa, the Desmidiæ, and to some other branches of natural science" are nearly completed.

The value of this work will be fully appreciated without further remark from us, but in closing this brief notice we must express high commendation of the excellent mechanical execution of the work, as well as of the accuracy of the text.

The New Botany, a Lecture on the best Method of Teaching the Science. By W. J. Beal M. Sc., Ph, D., Professor of Botany in the Agricultural College, Lansing, Michigan. [From the Transactions of the Twenty-ninth Annual Meeting of the Michigan State Teachers Association.] Second Edition, Revised. Philadelphia: C. H. Marot. 814 Chestnut Street, 1882 (Pamphlet, pp. 16. Price 35 cents.)

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

WANTED—To exchange, good slides correctly named, or material for mounting for same.—F. C. Smith, Bridgeport, Conn.

WANTED—Diatomaceous material from New Hampshire containing *Amphipleura Lindheimeri*, in exchange for materials from North of Ireland.—William A. Firth, Whiterock, Belfast, Ireland.

Striatella unipuncta, *Rhabdonema Adriaticum*, and other first-class crude material, to exchange for named diatoms and first-class material—prepared and particularly foreign material preferred.—M. A. Booth, Longmeadow, Mass.

WANTED—Animal parasites, Ixodes, Acari, etc., either mounted or unmounted.—W. A. Hyslop, 22 Palmerston Place, Edinburg, Scotland.

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Coral in an Aquarium.*

BY W. E. DAMON.

I have had several varieties of living coral, including *Astrangia*, *Occulina*, *Porites*, *Meandrina*, etc., growing in my marine aquarium; only the first of which I shall speak of in this paper.

I have watched it for hours and days at a time with the greatest delight, and I used to think that no well-regulated family should try to exist without a specimen of live coral; but that may be an exaggerated idea of the subject, and I have learned to conceive how this may be possible. The beauty of a fine zoothome (that is, a number of coral polyps on a branch of coral), fully expanded and scarching for their food, is almost indescribable—a branch of the most exquisite flowers, a living royal bouquet; to the naked eye, in fact, what some of those beautiful minute objects, which your Society have so kindly shown to me from time to time under the microscope, seem to you, and that, I'm sure, is pretty enough! My first specimen, *Astrangia*, as described by Dana, was about as large as the palm of the hand, encrusting an uneven surface of stone in nodular shape. When the polyps were all out of their calicle, the zoothome, or animal part, with long, slender, thread-like, fleecy tentacles, dotted all over with little knot-like markings, extended in all directions in search of food. Some of the polyps were nearly an inch in height above their calicle, and in diameter nearly as large as a pipe stem, the mouth situated in the centre of the tentacles, as in the actinæ. In feeding them with pieces of clam, oyster, chicken, or raw beef, I sometimes hand to each individual a piece separately, but generally cut it up in small pieces, in size from the head of a pin to a grain of wheat, and drop them into the water directly over the polyps, when every piece is securely seized by their outstretched arms, passed along slowly but surely to the mouth, and swallowed. All of this can be plainly seen through their semi-transparent, glassy walls. After digestion has taken place the animal sinks down in its calicle to rest.

These long, fairy-like tentacles, implements for gathering food, however, are not the innocent objects they seem to be, as many an unlucky shrimp or crab can testify, for each one of them carries concealed in the little knot-like protuberances already mentioned, a perfect armory of weapons of warfare called lasso threads, with which they shoot out their poisoned arrows.

I have seen a poor shrimp accidentally pass too near one of these groups when he would receive such a shock as to make him jump clear out of the tank and fall upon the floor—and others that would curl up in a trembling sort of way, turn white and die.

An association of these polyps must be of a most intimate kind; though each individual has a separate mouth, tentacles and stomach, the intervening tissue which connects them is subject to a free circulation. Their principal business, however, is

*Read before the New York Microscopical Society, November 17th.

eating and depositing a strong stony structure at their base and sides. I have observed a number of infant polyps budding off the sides of the group, and this usually occurs during the autumn months.

—o—

Examination and Exhibition of Living Organisms.

In studying minute, living specimens of animal life it is often difficult to keep them alive for any considerable length of time. Active, free-swimming creatures, such as the microscope reveals, find an ocean in a little drop of water under the cover-glass, and it is impossible to study them carefully unless their movements can be restrained. The water evaporates from beneath the cover-glass with such rapidity that some means must be devised to prevent drying. Ingenious devices of various kinds have been described in the JOURNAL from time to time, by means of which the evaporation may be prevented. Perhaps the simplest method of all, and one as satisfactory as any of them, is this: Place a drop of water containing the organisms on a cover-glass of ¾-inch diameter, and invert it over a ring of wax or paraffine on a slide. Then melt the wax with a piece of wire to cement the cover-glass and make an air-tight cell. It is well to place a small bit of *Nitella* or *Anacharis*, or some vigorously growing alga in the drop of water. In this way rotifers can be seen to develop and multiply for days, *Cyclops*, *Daphnia*, and other entomostraca will flourish in cells thus made. To confine the movements of swimming organisms, a little clean cotton can be placed in the drop of water, in the meshes of which they become entangled, and are then readily kept in view for two hours or more. The plan is an admirable one when cyclosis in a water plant is to be shown. It is well known that cyclosis is always most vigorous some time after the specimen is prepared and allowed to remain undisturbed in its cell. Often the movement is entirely stopped by cutting, or otherwise preparing the plant, and is not again active for an hour or more; in consequence of which many disappointments occur in attempting to show this phenomenon. But by putting the specimens in such a cell a few hours before they are needed, there need be no disappointments.

—o—

New Process of Preparing Diatoms.*

BY PROF. W. BRUN.

Prof. Brun has used the following process for destroying the endochrome of diatoms with great satisfaction.

If the diatoms are freshly gathered and still moist, add to them a few crystals of potassic permanganate and a very little water; if they are dry, pure or mixed with organic debris, they are treated with a very concentrated solution of the same salt.

The action of the salt should continue at least twelve hours. It is well to stir the mixture occasionally in a vial of about 100 grammes capacity, placed in a warm place, exposed to the sun.

The vial is then half filled with water, and about 30 grammes of calcined magnesia are added, and the whole well shaken. After two or three hours, pure hydrochloric acid is added in portions of about one gramme at a time, adding ten grammes in ten minutes.

For very delicate species, or those having lime in their composition, the action of the acid may be regulated by using a larger quantity of water.

With frequent agitation the action of the chemicals is allowed to continue, aided by heat if necessary, until the contents of the bottle lose their color, after which the diatoms are washed in the usual way.

In this process we have first the

* *Bulletin de la Soc. Belge de Microscopie.*

energetic oxidation of the endochrome by the permanganate. In fact, if the diatoms are then examined with the microscope, their entire organic matter will be seen coagulated, brown or black and already greatly modified. By the addition of the acid, there ensues a disengagement of oxygen, which burns up, and of chlorine which decolorizes: it is undoubtedly to these different and successive reactions that the perfect cleanliness of the silica, without corrosion, is to be attributed. In fact, the surface of the diatoms appears pure, and with all its lustre: it has lost its organic envelope, and the finest details (striæ, punctations) are clearly to be seen.

I have tried the different chemical methods that have been successfully announced during late years, but I have not found one of them which succeeds so regularly.

——o——

The Mounting of Pollen Grains.

There are few objects more beautiful, when properly mounted, than pollen grains, and the variety of their form is almost endless. They may be mounted either dry or in fluid, but in the latter case the proper liquid medium should be chosen. Water is not considered a good mounting fluid for grains of pollen, and balsam is not suitable. Perhaps one of the best mediums is castor oil, which clears the grains beautifully, and shows their markings very distinctly; but it is an easy matter to experiment with each specimen, using different fluids, before mounting permanently. Whether they should be mounted dry or in fluid depends upon the taste of the mounter more than upon other considerations.

Dry mounts can be made by preparing cells as for opaque objects, and scattering the grains over the bottom. Wax cells are excellent for the purpose. They may be made by cutting out circular pieces from a sheet of olive-green wax, such as is used in making wax-flowers, by means of a gun-punch, pressing this upon the centre of the slide and placing a brass curtain-ring upon it. The application of a gentle heat below will soften the wax so that the ring will sink into it sufficiently to hold, or it may be pressed down by means of a slip of glass without throwing it out of place. The wax should not be melted, for in that case it loses its smooth surface and spoils the appearance of the bottom of the cell.

When the wax cools, put the slide on the turn-table and finish up the outside of the cell with any thick cement or varnish. We prefer to finish the cells in this way before using them for mounting.

When ready to mount, dust in the pollen grains and run a thin layer of shellac around the top of the cell. This soon becomes tacky, and the cover can then be immediately applied. After a few hours the cell may be finished with black or colored cement.

Cells may also be made for pollen-grains out of cement or varnish, and the bottoms can be coated with some dead-black paint, or the glass may be left clear so that transmitted light may be used.

For mounting in oil the cell is best made of plain shellac. It should be just deep enough to protect the grains from pressure when the cover is applied. Shellac is a good cement to fasten the cover down, so also is hard balsam dissolved in benzole.

Pollen grains usually make fine objects by reflected light, and one of the most beautiful objects to be seen is a mass of pollen grains from the morning glory displayed on a dark background. The transparent mounts should be examined with a parabola, spot-lens or Webster condenser, so as to display the grains on a dark field. Many of the plants that bloom indoors during the winter have very beautiful pollen grains, so this article cannot be out of season even though published so late in the year.

On the Processes of Coloring Living Microscopic Organisms.

BY A. CERTES.*

In describing before the Society the processes of coloring living tissues by cyanine or quinoline blue, or Bismarck brown, I remarked that the nucleus of infusoria seemed not to be colored by the reagent so long as the animals continued to live, and even for several hours after death. Nothing has occurred to contradict the first observations. I have only found that the cyanine colors the living tissues even when the amount in solution does not exceed one five hundred thousandth part ($\frac{1}{500000}$).

Dr. Henneguy having informed me of the analagous properties of a methyl violet known as dahlia, I have pursued these experiments with different violets of Paris, and I have found that, despite their very similar chemical composition, their action varies according to the kind and also to the trade-mark. Some are always poisonous to all species of infusoria. Others only color certain species among those that live in the same liquid. Others finally,—and it is to this point that I call attention of the Society—color the nucleus of the living infusorium and color it more strongly than the protoplasm.

In general, with the violets of Paris the cilia are always stained, and the liquid of the contractile vacuole—so far as one can judge in an observation of such a delicate nature—often participates in the general coloration.

As concerns the nucleus, I have ascertained in a most evident manner the selection of the coloring matter, by it, first with the violet B B B B B. upon the large *Balantidium* from the intestine of a *Bombinator igneus*, and in other species † with the violet B B B B B and dahlia violet. The violet 50 N, and the gentian violet, on the contrary, notwithstanding their great power of coloring, have no tendency to go to the nucleus.

As to the more or less great resistance that certain closely allied species oppose to the action of the same reagent, I will cite the fact, in support of my observation, that I have seen in the same liquid, small species of Paramecia * continue to live indefinitely without being colored, while all the others of equal or greater size had entirely disappeared.

The coloration of the nucleus of the infusoria is a new fact. It is so much the more interesting to ascertain that the more recent researches demonstrate the preponderating role which this element plays in the phenomena of nutrition and reproduction, and, if one may also so speak, in the government of the life of unicellular organisms.

* Translated for this JOURNAL from the *Bulletin de la Société Zool. de France.*

† *Paramecium aurelia*, Vorticellas, Oxytriches, *Stylonychia*, *Volvox globator*

—o—

The Podura Scale.

BY THE EDITOR.

The scales of the insect, long known by the name of *Podura*, have been renowned as test-objects for many years. They are not test-objects in the sense of being difficult to resolve, for, as Dr. Carpenter has said, a good 2-inch objective will show their markings; yet they are valuable for testing objectives of all powers up to a twentieth or fiftieth. The podura-scale has been the subject of much study by microscopists in the past, and eminent authorities have differed very much in their interpretations of the microscopic appearance of the scale, which, under different conditions of illumination, could be greatly changed. Dr. Royston-Piggott described a beaded appearance, which he deemed to be the true structure. Mr. R. Beck maintained that the proper microscopic appearance was that of rows of exclamation points. Without further allusion

* Probably *Paramecium pectinum.*

to the experiments of a few years ago, the question has forced itself upon several microscopists of this city while examining objectives from different makers: "What is the proper appearance of the podura-scale?" It is not now a question of structure but of appearance. It is found that a Wales objective gives a different appearance to the markings from a Tolles. Both give sharp images, but they are not alike. Which is the best objective—in other words, which image is the correct one? It is difficult to describe the different appearances without illustrations, and the purport of this article is merely to direct the attention of observers to the subject, as it is our intention to return to it at some future time when suitable cuts can be obtained.

With some objectives each "exclamation point", or spine as we shall designate it, appears to have a longitudinal slit of light, tapering at both ends, the broadest part near the top of the spine. With other objectives the line of light appears to have a distinct head at the upper end, from which it tapers away. While some objectives clearly show the point where the spine seems to be attached to the scale—that is, they very sharply define the tapering end of the spine—others show only the upper part of the spine, the small end being "fuzzy" and fading away indefinitely. It is not usual to see the spines just as Mr. Beck has figured them. A cheap Beck objective gives the nearest approach to that appearance of all.

In these observations, which were made by several persons together, a number of objectives of the same nominal focal length, and of the same angular aperture, were compared under identical conditions, and others of different powers were used with oculars which afforded approximately the same magnifying power.

The result is, that it is still a matter of uncertainty how the podura-scale ought to appear.

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Cleaning Diatoms.

REPLY TO MR. KITTON.

Having been absent in the mountains, I did not see, till the latter part of last month, the reply of Mr. Fred. Kitton, Honorary F. R. M. S., in the August number of the JOURNAL, to my article on "The Preparation of Diatoms," published in the June number. Though I had not unfrequently seen the *Science Gossip*, I had never met with Mr. Kitton's articles, nor heard of them till I saw his reply. My article was actually written about five years ago, and I then showed it to Mr. Charles Stodder, of Boston, Mass., well known to microscopists, who advised me to offer it for publication. I did not, however, and it laid among my papers till I took it up last March. With slight revision, it is the same as I wrote five years ago. Previous to 1877, I, in correspondence, and verbally, related the process as I have described it in my article, and I have done so since 1877. After reading Mr. Kitton's reply, I wrote to Mr. Stodder; he looked up Mr. Kitton's articles, and he writes me (he had never seen them before) that Mr. Kitton's description of the process is, indeed, very like mine. I can only say, this is coincidence. Had I known of Mr. Kitton's articles I might not have written upon the subject; or, had I written, I would have given him full credit. My purpose in offering my paper for publication was to present a simple, clear, concise account of the process from beginning to end, for large quantities of material as well as small, of the preparation of diatoms, such as I had not found in books or science publications, and such as I thought most of those, beginners especially, interested in the study of these beautiful objects, had not found. The claim to originality lay especially in the extended mode of getting rid of the sand. The chemicals I knew had been used before, if not in the same order. With

regard to filtered water, I had in mind soft water, such as I had been in the habit of using, and not water obtained in calcareous ground. Such water, thoroughly filtered, can hardly, I think, be practically different from distilled water.

The name "sub-plutonic" has been given to diatomaceous deposits found under beds of lava. They are found in regions where, in the geological changes, there have been great upheavals, subsidences, and volcanic action. They are hard from the heat of the lava at the time it overflowed the deposits.

R. S. WARREN., M. D.

COLORADO SPRINGS.

[A previous communication from Mr. Stodder confirms the above. Mr. Stodder writes: "I was surprised by the resemblances;" the difference is "mostly in phraseology." This is only one of many curious coincidences which abound in literature. —ED.]

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Lithological Microscope.

The application of the microscope to the examination of rocks has become of great value to the lithologist and mineralogist. Not only has the microscope thrown much light upon the origin of rocky strata which contain the remains of organic forms, but it has also led to a knowledge of the mineralogical composition of rocks, and of the transformations which they have undergone, far more intimate and certain than chemical analysis could ever afford. We illustrate this month one of the many forms of petrological microscopes now to be obtained. It is an English instrument, made by Mr. Watson, of London, which has proved quite satisfactory to those who have used it. Stands for the same purpose are made by Mr. Bulloch, and the "acme lithological" is sold by Messrs. Queen & Co. and by Mr. Woolman. Our read-

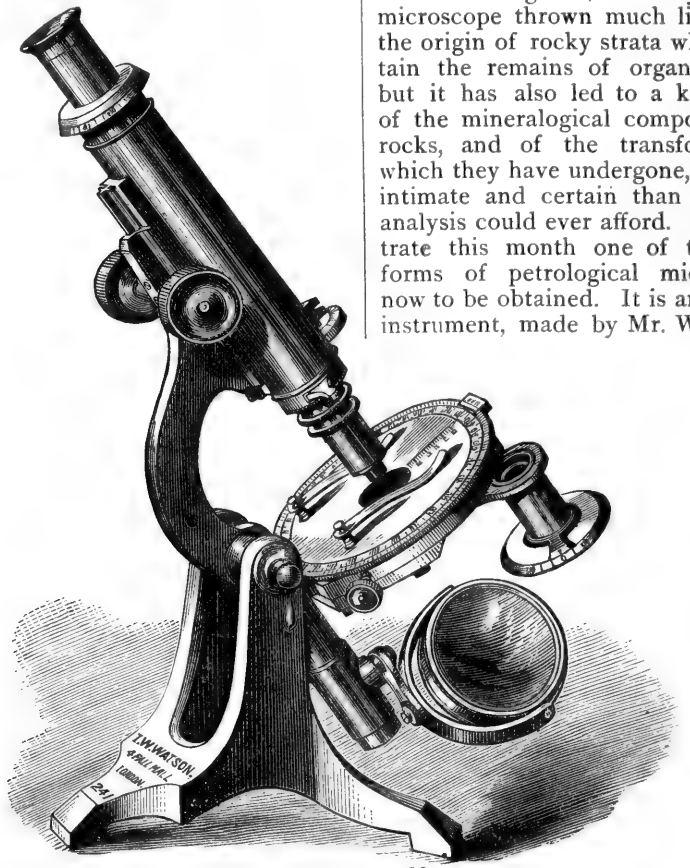

FIG. 44.—LITHOLOGICAL MICROSCOPE.

ers may now compare the American stands with the cut of the English stand.

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Examination of Water and Air for Sanitary Purposes, with Remarks on Disinfection.*

It is well known that the presence of chlorides, nitrites, etc., in water, is indicative of contamination with sewage, or with organic matter of some kind, and, by general consent, such waters are regarded as unsafe for household use. On the other hand, it must be admitted that the constant use of such waters for drinking is only occasionally followed by diseases which can be attributed to them. Certainly chlorides and nitrites are incapable of producing contagious diseases. Therefore, there must be another element in those waters which produce typhoid fever for example, that may or may not accompany the compounds mentioned. At present it is almost universally conceded that this element is a living microscopic germ, which develops and multiplies in the water. If this is true, it is obvious that the results of a chemical analysis are quite incompetent to prove the healthfulness of a water.

Granting this, it may be argued that chemical examinations are quite useless for sanitary purposes. The fact is quite otherwise. For although the chemist cannot detect the germs of disease, which likewise baffle the scrutiny of the microscopist, his analysis indicates the source of contamination. It enables us, therefore, to trace the contamination to its source, and thus determine its nature.

Perhaps it will be a somewhat startling assertion to say that the drainage from vaults containing human dejecta is not necessarily unhealthful. Yet the truth of it is demonstrated by the immunity from contagious diseases of thousands of families whose wells are situated close by, and below, such vaults. Sanitarians become greatly excited over the condition of affairs in this respect all over the country, and they predict most direful epidemics. But, somehow, the epidemics do not come. Chemists examine the water, Boards of Health order the wells closed, and families complain of the injustice of it because they have never suffered from the use of the water. Evidently theory and experience do not correspond.

Nevertheless, the explanation is simple enough. Let there be a single case of typhoid fever in a house when the well is thus contaminated, and the probability is that those who drink the water will also take the disease. The germs will be carried into the well. They may be disseminated from it through the entire community, and the result would be, and often has been, a wide-spread epidemic. This is a fact of observation, and quite independent of any theory of the origin of disease. Therefore, chemical examinations of water are of value, not in that they prove that the water is unhealthful, but because they indicate the possibility of its becoming a vehicle of disease, and point out the source of the contamination.

Air which is chemically pure may be a vehicle of contagion; and air which is chemically very impure may be perfectly harmless as regards contagion. In other words, sewer gas, whatever that strange combination of odors may be, is not, *per se*, a vehicle of contagion. If it were, the population of New York City would be decimated every year. * * * *

I would not say that the health of the city was not affected by the condition of the streets. Very likely it was; but the effect was merely that of air contaminated by the gases arising from the decomposition of refuse matter, utterly incapable of breeding a pestilence. Ammonia and sulphuretted hydrogen, and the various other gases which arise in this

*Abstract of an article by R. Hitchcock, published in the *Journal* of the Franklin Institute.

way, do not produce contagious diseases.

But if the atmosphere carries the ms of disease, it is not unlikely that these will be most active where the air is impure. For, if these be germs of living organisms, they will doubtless find a suitable nidus for growth and multiplication where decomposition is going on, and they will be disseminated by the rising gases. It is very likely that some of them increase in virulence when they grow shielded from the free access of air. But so long as the germs are absent, sewer gas or effluvia of any kind will not generate contagia.

About three years ago Professor R. O. Doremus read an article before the Medico-Legal Society of New-York, entitled "Epidemies from a Chemical Standpoint." In the experiment which he then performed the permeability of sandstone, brick, etc., to gases was demonstrated. This fact is well known to chemists, but the experiment proves nothing more than that the poison of contagia may be retained by the porous walls of houses. It should not be inferred, however, that the contagia are able to pass through the stone, for that has not been proved and is, indeed, highly improbable.

Experiment indicates that all the floating germs of contagious disease may be filtered from the air by means of cotton. Gun-cotton can be employed for this purpose, after which it can be dissolved and the germs will settle to the bottom of the solution where the microscopist can find them. There are also other methods of collecting them for examination. The microscopic examination of air is, therefore, very important. But it should only be entrusted to careful investigators—persons who are not too hasty in drawing inferences from experimental results. The more one studies the microbes of the air, the more fully he realizes the immense field to be gone over before the results can be properly interpreted. To definitely declare the relation between these microbes and specific diseases now, indicates a very superficial knowledge of the subject. For it is impossible to distinguish by sight between a bacterium that is virulent and one that is harmless.

The results of experience may, therefore, be summed up in a few words, thus: We have no means of determining when a water, which analysis shows is liable to become a carrier of disease, does become active in its dissemination, nor can we yet determine whether the air we breathe is or is not loaded with the germs of disease.

But we cannot doubt that after years of continuous observation by competent persons, satisfactory results will be obtained. I regard it as a national misfortune that the National Board of Health has been unable to secure an appropriation adequate to continue its work and the publication of the *Bulletin*.

Sceptics may question the value of these investigations, but let us look for a moment at the actual results in saving human life, shown by the statistics of England and Wales for successive periods of ten years since 1841. The annual death rate for those countries for ten years, from 1841, was 22.4 in 1,000 persons; for the next ten years it was 22.2, and for the next ten years, up to 1870, it was 22.5. For thirty years, therefore, it remained quite stationary. Then sanitary science was applied to diminish the death rate, and in the next ten years, from 1871 to 1880, it fell to 21.5. This represents the saving of a quarter of a million lives. A further examination of the statistics also shows that this saving of life is in great part due to the effect of sanitary laws upon the prevalence of certain zymotic diseases. In exact figures, 0.78, or more than three-fourths of the improvement is due to this alone. The fever death rate has fallen from 0.80 per 1,000, in 1870 to 0.32 in 1880.

Another subject, upon which there

is considerable misapprehension, is the efficiency of disinfectants. Here again the sanitarian can act without relying upon any theory of disease; for whether there be a living germ or a chemical poison, the disinfectant must be strong enough to kill the one, or at least to render it inactive, and to decompose the other. The utter inefficiency of carbolic acid vapor, or of any aërial disinfectant whatever, in a sick-room, will be evident to any one who is familiar with the microscopic study of living germs. For it is known that they can withstand treatment with chemicals which would instantly destroy the life of higher organisms, and no atmosphere which we could breathe would destroy, or materially affect the vitality, or activity of, disease-germs. It may be said that ordinary aërial disinfection is utterly useless. The only efficient method in the sick-room is the immediate disinfection of all refuse, and thorough ventilation.

A more accurate knowledge on the part of some persons, of the capability of germs to resist destruction, would prevent the advocacy of absurd and impracticable schemes for disinfection, such as the freezing out of yellow fever from a ship, and others of like character. It may be assumed, with a fair degree of probability, that yellow fever, or any other contagious disease, will not be carried around in a ship's hold if the latter is thoroughly aired and ventilated; and by a proper regard to sanitary conditions, the quarantining and disinfection of vessels after long voyages from infected ports, would be rendered quite unnecessary.

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Unpressed Mounting for the Microscope.*

By Alfred W. Stokes, F.C.S.

Blue bottles are still in season! At every window, with very little or very great *panes*, the microscopist, on that happy hunting ground, may meet the buzzing monster. There are few cabinets in which "the Tongue of a Blow-fly" is not to be found; it haunts the boxes of "The Postal Microscopical Society" with painful regularity; go to any *soirée*, and you will, with certainty, through some brazen tube, see the blow-fly putting out his tongue at you. Most books on the microscope seem to open easiest at the picture of "the tongue of a blow-fly"; they almost all have a drawing of it. And all these many tongues apparently conspire to utter the same misstatement of fact; for how few of us have ever through the microscope seen anything but a squashed and flattened object;—a something as like the real thing as that flattened collection of dirty feathers over which several cart-wheels have passed is like the once gay rooster.

Now, seeing these are serious objections to the too common method of mounting, and suspecting that most of this distortion of nature results from not knowing how else to preserve microscopical objects, we would lay before our readers what we consider a better, easier, and more natural method:—a plan in which, from the beginning to the end, the true shape of the object is preserved.

Let us try whether we cannot mount our tongue of blow-fly, for instance, so as to see its true shape; to have it transparent in every part; to be able to view each hair, every ramification of the internal organs, tracheæ, etc., just in the positions they naturally occupy.

And, firstly, it is not necessary to wait till our blow-fly has his tongue protruded over some piece of sugar, and then deftly to cut it off with a pair of scissors. Nor need we squeeze the head to make the tongue protrude, nor pull it out with tweezers. All such methods mean the expenditure of a lot of time, and the slaughter of a number of blow-flies, with the production of a few more or less

* From *Journal of the Postal Microscopical Society*.

damaged and fragmentary objects. In fact, we will not cut off the tongue at all, but mount it in its natural position on the head; for our blow-fly's neck is so slender that there is no difficulty whatever in decapitating him. We will, therefore, do so. Now, if we consult our books on microscopical mounting, we find that we must first dry the head, and then soak it in turpentine; or, as some say, put it at once in turpentine and *wait* till it is transparent. If mounting anything but horses had been in vogue in Methuselah's days, such methods would have been then well worth trying; there was no need for hurry in those happy times. Those, perhaps, were the days when they placed knobs of "Wallsend" in carbonate of potash solution, and fished them out a century or so later, just nice and soft for cutting coal sections. Alas! this is now a lost art, in spite of the plain directions given in various works on microscopical mounting! But as we cannot wait the months necessary for the blow-fly's head to become transparent (if it ever would by this process), we will try a shorter plan; for even in microscopical mounting it is of some advantage to be reasonable. And in order to make it transparent, we have first to get rid of the mass of coloring matter and of all air; since, of all things, air diffused through an object is the most *in*-transparent,—difficult to get rid of, and misleading in its appearances to the microscopist. Most bodies contain about seventy per cent. of water, and in drying an object, therefore, we get rid of all this, partly by shrivelling up the object, partly by replacing the water with air. Then, having spent some time and effort to get the object well filled with air and nicely shrunken up, we set to work with still greater trouble to get the air out again, and to puff out the specimen to something like its former shape. Hence, whatever else we do, we will *not* dry our object. That part of the tissue of the blow-fly's head which is not swollen with water is filled with air; and so, while taking out the coloring matter, it will be an economy of time to get rid also of some of the air. What apparatus do we need for this? would not an air-pump be of use? By all means, if you can afford it, and if you wish to add another to your array of instruments go and purchase an air-pump, and do whatever you like with it, only do not use it for microscopical mounting. Go, instead, and buy a half-penny test-tube; for a solitary test-tube is the whole of the preparing apparatus needed in this method!

Into this test-tube place the fly's head, and fill the tube half-full with a solution of soda or potash. Stand the tube in a cup or tin pot of boiling water, and leave it on the hob of a fire or other warm place to keep hot till morning. Then examine the head and see if it looks almost transparent; if not, pour off the soda-solution, and add a fresh supply, and again keep the tube hot till the object becomes semi-transparent. Now pour off the solution and add hot water, in a few minutes emptying it out and adding some more; repeat this at least three times, and finally leave the last quantity of water on the object for an hour to cool. Next pour off all the water and replace it with spirit of wine; methylated spirit, if strong, will do sufficiently well. Heat this by immersing the tube in a vessel of hot water for one minute; then take it out, cork it up, and leave it for one hour.

So far, we have, by means of the soda-solution, destroyed all the flesh and fat-tissues, leaving only the cuticle and internal organs, such as the tracheæ, etc. In doing this, we have filled up most of the few natural air-spaces with soda-solution; which, however, being a somewhat dense fluid, would not enter many of the narrow tracheal tubes. Then with water we replaced the soda-solution, and washed away the parts destroyed

thereby. On replacing the water by alcohol — a still less dense fluid— more of the finer air-spaces are penetrated and the air driven out : there are still, however, some tubes too minute even for alcohol rapidly to enter. So now we pour off the spirit, and add ether instead, which answers a double purpose;—it enters readily the very minutest passages, displacing the contained air, and it also dissolves the globules of fat left unsaponified by the soda-solution. After leaving the ether for fifteen minutes in the corked tube, and shaking it once or twice, we pour it off and add turpentine; and then in ten minutes' time our blow-fly's head is ready for mounting in Canada balsam or dammar.

But if so mounted, it will be very difficult to see much of the finer internal structure, since these media render some parts far too transparent; hence some of the glycerin media are preferable. In such cases, after pouring off the ether add alcohol and at the end of fifteen minutes replace the alcohol with cold water, and leave for fifteen minutes more. Then the water, may be poured off, and the mounting-fluid, whether glycerin, carbolic acid, gelatine, Goadby's or Thwaites' fluid, may be added. The object, if mounted in any of these, will have a far more natural appearance, and show more plainly the finer structures, than if mounted in Canada balsam. The times mentioned above are those it is *necessary* in most cases to wait, but longer intervals would often be preferable. If we are busy, the tube and its contents may be left at any stage of the proceedings for days, with a certainty that the object will only benefit by the delay; *except* in the case of the soda-solution. Of course, when the object is transparent enough, a longer stay in that solution would only render it *too* transparent, and so spoil it. It is not necessary to use distilled water, though it is better to do so; but whatever water is used, it should have been just freshly boiled and be used hot. Cold, unboiled water contains a large quantity of air, and if used in that state will certainly impart air to the object instead of helping to extract it.

The soda or potash-solution is made by adding solid potash or soda to eight times its weight of boiling water.

The spirit and the ether, which have been used during the process, should be poured off into a separate waste bottle, either to be afterwards redistilled, or for use in some other way :—ether, being highly inflammable, should not be brought near a light. The only expenses are for soda, alcohol, ether, and one tube; of the alcohol and ether there is practically very little waste, as a pint of each will prepare some thousands of specimens.

So far, we have written as if it were only the blow-fly's head that we wished to prepare ; but it is obvious that in the same tube we may have some dozen or more insects, or parts of insects,—only being careful to remember which is which. The same system will answer likewise for plant specimens, such as sections of wood, small seed-vessels, leaves, etc. Only in their case they should first be decolored by pouring sodic hypochlorite into the tube ; then, after well washing with water, the rest of the process may be followed as before, leaving out entirely the use of the soda-solution. The great difference is in the matter of speed, as vegetable preparations can be made far more rapidly than insect ones. It is possible by this method to cut a dozen sections from a living branch,— bleach, stain, and mount them in Canada balsam or glycerin-solution, —and finally, ring and label them, all within the hour.

Should some of the preparations— our Blow-flly's head, for instance— become too colorless and transparent, all we have to do is to stain such by the addition of a few drops of an

alcoholic solution of some coloring matter (logwood answers well) to the alcohol in the tube. The subsequent use of ether will fix the color.

Usually after this treatment, the object will be found to be quite clean; but if not, it should be gently brushed with a camel-hair pencil while in the turpentine or glycerin-fluid. The wings of many insects are partially destroyed during the process, but since these can, if desired, be easily mounted separately, this is not of very great importance.

The next point is how to mount our objects without pressure. Small insects,—such as ichneumon-flies and gnats,—parts of insects, such as the legs, etc.,—leaves and other portions of plants, may be mounted in shallow cells, formed by running a ring of gold-size or "brown cement" on the glass slip. The brown cement is very useful for this purpose, and is highly recommended where a rapidly-drying and firm cement is required. For those to whom expense is no object, the slips having cells hollowed out in the centre should be chosen.

Larger objects will need a deeper cell than any of these afford; and to form such, vulcanite rings are undoubtedly the best, as also they are the cheapest. A number of these rings, of various thicknesses, should be cemented to ground-edge glass slips. Let no true microscopist indulge in the paltry saving effected by using slips with rough edges. Though anyone possessed of such ultra-frugality may have the right to cut his own fingers with their sharp edges, he has no right to endanger the cuticle of his friends: and if he intends to prevent this by covering up the slide with some of the harlequin papers too often used, he will find that there is no economy in the double purchase, either in the matter of time or expense.

Having prepared a number of vulcanite cells a day or so beforehand, we select one just a trifle shallower than the object to be mounted: and if the mounting is to be in any other solution than Canada balsam or dammar, we proceed thus:—The top edge of the cell we cover with a thin layer of brown cement; then we breathe into the cell, and before the moisture dries fill it up with the solution for mounting in. If we did not breathe into the cell, there would probably be an ugly rim of minute air-bubbles clinging round its bottom angle. Into the cell we now place our blow-fly's head or other object, and with a needle or small sable-brush arrange it in the centre in any desired position. Insects mount best by placing them on their backs.

After seeing that the cell is brimful with fluid, we take up a clean cover-glass of such a size that it is not quite so wide as the full width of the vulcanite ring, and on the under side of this we breathe gently: then quickly place one edge downwards on to the vulcanite ring, in the position it will finally occupy, and somewhat slowly lower down the opposite edge on to the ring till the cover-glass lies flat. If this is properly done, there will be no air-bubbles in the cell, nor any clinging to the cover-glass; neither will the object be forced from its central position. To ensure the still tacky cement fastening the cover-glass securely, we place over the whole a slight spring-clip, and leave the mount thus for some hours. Then the clip may be taken off, and the slide washed under the tap; when dry, a new ring of cement should be placed on the edge of the cover-glass and on the outer edge of the vulcanite ring: to which any rings of colored cement may afterwards be added. There are few finishing cements that are equal in appearance, or so durable, as that made by adding one-third of gold-size to some Brunswick black: it dries rapidly and is tough and elastic.

For mounting in Canada balsam or dammar, we make a similar ring of brown cement on the vulcanite ring. Inside the ring, or cell, we

place a drop or two of turpentine, which we then shake out again, and fill up the cell with the fluid balsam. Into this we place the object, taking it from the turpentine in which it had been left to soak, and arranging it in the cell. On the under surface of a clean cover-glass we place another drop of turpentine, allow it to run off, and then lower down the cover-glass just as in the former case. After the spring-clip has been on for a day or two, we can carefully scrape off the excess of balsam, wiping the top carefully with a rag moistened in spirit, and then running a ring of cement round the edge as before.

And now we have mounted, let us say two heads of the blow-fly,—one in glycerin fluid, the other in Canada balsam. Let us see how they look through the microscope. Our first impression is—how different the object appears to that spread-eagle thing we have so often looked at! Why, we can actually focus down and see, first, the tips of the hairs on the fly's head; then we see their insertion on the scalp; and focussing somwhat lower we enter the cavity where once part of the brains were, —only a cavity now, through which meander a pair of tracheal tubes, but where once our blow-fly did all her thinking,—where she laid her plans for stealing our sugar, and for the safe depositing of those minute progeny so dear to the cultivators of the gentle angling craft. Lower down still we come to the roots of the hairs at the base of the skull. We really must have revolved our fine adjustment-wheel some dozen times, and we remember how formerly, with only half a turn, we used to find ourselves at the other side of our flattened specimen.

On each side of the globular head stand out the many-facetted eyes. At the base of the proboscis which juts out from the front are the strange pair of antennæ. In the middle of the proboscis stand out the palpi. In a groove near its end lie the sharp setæ or lancets. The end is swelled out by a beautiful network of pseudo-tracheæ into two semi-heart-shaped masses, between which we discern the salivary tube. And now it is easy to understand how the sugar disappears. There, under our binocular, the tongue of a blow-fly stands out solid, and looks as we never saw it before; it is more than ever a thing of beauty, but its use also is plain. Turning over the slide, we notice underneath the narrow opening from which some tracheæ still project, and through which there once passed nerves, muscles, digestive canal, and tracheæ, from the head to the body.

Let us henceforth resolve that we will no longer crush out of their real semblance any more of nature's beauties, no longer fill our minds with false notions of the truth; but preserve, so far as we can, the true and lovely form that nature everywhere bestows upon her creatures.

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An Easy Method of Detecting Bacillus Tuberculosus for Diagnostic Purposes.*

BY GEO. A. PIERSOL, M. D.

* * * At the present time there is, probably, no other subject receiving more earnest study and careful investigation than that of the discoveries of Koch regarding the bacillus of tubercle. While these researches bid fair to yield the most important results, it is no disparagement to that excellent observer to assert that extended investigation into the modifications naturally resulting from the manipulations of different workers, will alone develop and complete our knowledge of the conditions of existence and life-history of the micro-organism, and determine the exact value of its pres-

* Abstract of an article in the *Western Medical Reporter*.

ence or absence from a practical stand-point.

It will be remembered that the demonstration of the presence of this bacillus, as well as its chief distinctive feature, depends upon its appropriation of certain coloring matters, while the ordary bacilli of putrefactive change remain unaffected. Heretofore the method employed by Koch has been very unsatisfactory, on account of its uncertainty and often entire failure; the modifications suggested by Ehrlich yield more uniform results, without, however, overcoming the element of uncertainty.

Recently, in *The Lancet* of Aug. 5th, Dr. Heneage Gibbs has given his plan of staining the bacterium, claiming for the method uniformity and certainty of action. * * *

The coloring matters employed are magenta crystals and chrysodin (chrysoidin); the latter is a brown, staining the ground-substance, but with less intensity than vesuvin. These solutions are required:—

A.—Magenta crystals, 2 gram. Pure anilin, 3 gram. Alcohol (s. g. 830) 20 c.c., Dist. water, 20 c.c.

Dissolve the anilin colors in the alcohol, rubbing them up in a glass mortar, adding the spirit gradually until all the color is dissolved, then add water slowly while stirring. Keep in a stoppered bottle.

B.—Saturated solution of chrysoidin in distilled water; add a crystal of thymol to prevent deterioration.

C.—Dilute solution of nitric acid —one part of acid to two of distilled water.

The following is the process of staining suspected sputum:—

Spread a thin layer of sputum on a cover-glass, and allow it to dry; when quite dry, pass the cover two or three times through the flame of a Bunsen burner, and allow it to cool. Filter a few drops of solution A into a small watch-glass, and in this fluid place the cover with the charged surface down, taking care that no air bubbles are present. In the staining fluid the cover remains 15–20 minutes; then wash it in the acid solution C, until all color has disappeared; then remove all acid with distilled water, when a faint color again becomes evident; then, in the same manner, subject the cover to a few drops of solution B, filtered into a watch-glass, allowing it to remain several minutes, until it acquires a brown color; wash away all superfluous fluid in distilled water, and then place the cover in absolute alcohol; afterward dry it perfectly in the air, place a drop of Canada balsam solution on the cover, and mount.

* * * In successfully stained preparations the bacilli are readily seen with a good ¼ or 1-5-inch objective, being well exhibited with a ⅛ or 1-10.

In commenting on the diagnostic value of the presence or absence of these micro-organisms, Dr. Gibbs states that in cases of undoubted phthisis he readily found them; in those cases presenting suspicious symptoms, some yielded the characteristic bacillus, while in others it was absent. In duplicate slides prepared, the putrefactive bacilli remained unstained by the magenta process. * * *

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The Effect of Tobacco.

[The following abstract of an article in *Good Health*, attributed by that paper to the *New York Times*, may or may not be true. Probably it is not. The facts may be correctly stated, but whether the tobacco or the sea voyage or the change of climate was the cause of the gentleman's demise we are not informed.—Ed.]

"M. Decaisne offers no rationale of the action of the narcotic tobacco, and enters into no analysis of the disease now familiar to popular parlance as smoker's heart; but here his observations are supplemented by those of a careful microscopic observer,

who has discovered that all narcotics —opium and its preparations, hasheesh, etc., as well as tobacco—act in a peculiar manner upon the colored corpuscles of the blood, producing the phenomenon styled crenation; that is, the margin of the corpuscle, instead of possessing the absolute regularity of margin noticed in the condition of health, presents a series of scallops somewhat irregular in their distribution. When viewed by oblique light under the microscope, this appearance is found to be due to the conversion of the corpuscle into a minute sac, apparently containing some hundreds of spherical bodies about one four-thousandth of a millimetre in diameter. In a few hours the sac ruptures and the imprisoned germs or organisms escape into the surrounding plasma to form bacteria when the conditions are favorable. A few such crenated corpuscles, in the proportion of one to three hundred and fifty, occur in the circulation of persons in normal health, not addicted to narcotics, but in the opium and tobacco habits, when of long standing, the ratio is sometimes as high as one degenerated corpuscle to ten healthy ones, and often attains the figure of one to twenty-five or thirty. * * * * * * * * *

"An incident illustrating the sequel of this appearance in the blood occurred a few months ago in the office of a manufacturing optician of this city. As the professor of microscopy in one of our medical colleges dropped in, a gentleman of evidently large wealth and finished intellectual culture was just leaving the office with a cigar between his lips. He was a wealthy amateur, and had selected a valuable microscope, using a drop of blood from his own finger as a test object. The instrument was still adjusted and the slide still beneath the lens. The professor glanced at it; he moved the slide to and fro, so as to study one field after another; then counted a few fields, and made a rapid computation. The optician looked on in astonishment. 'That, gentleman is one of our best customers,' he said; 'buys more heavily than half a dozen professors.' 'And this is a drop of his blood?' inquired the man of science musingly. The purveyor of lenses assented. 'Very well,' replied the professor, 'tell your best customer, if you can without impertinence, that unless he stops smoking at once he has not many months to live.' But he did not stop. A few weeks later he went to Europe, thinking a sea voyage might recruit his wasted energies.

"In a few weeks more his death was announced by telegraph from Paris."

EDITORIAL.

Subscriptions.—Remittances for subscriptions should be made by post-office or express money-orders, by drafts payable in New York, or in registered letters. Money sent in any other way will be at the sender's risk. A receipt will be immediately given for money received by open mail.

The JOURNAL is issued on the 15th day of each month. Subscribers who do not receive their copies at the usual time are requested to inform the Publisher of the fact.

TO OUR READERS.—This number completes the third volume of this JOURNAL. To our friends, and to the many constant readers we have throughout the country, we extend our hearty thanks for the assistance they have given to the JOURNAL, during the early and uncertain period of its existence. To their liberality and confidence is due the present standing of this paper. In return we can only say that it is our desire to make the JOURNAL still more worthy of their support and interest during the coming year.

To all of them we wish a merry Christmas, and a prosperous, happy New Year.

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EXCHANGE-BUREAU.—There seems to be some misapprehension about the relations of the publisher of this paper and the Exchange-bureau.

The prices are fixed by the owners of the goods offered. Purchasers will observe that when the maker's price is quoted by the owner, it is given in the advertisement. The catalogue-prices are not always to be taken as expressing the value of the apparatus offered, as in some cases the apparatus was made for a special order, and therefore held at a higher value than the regular make of goods.

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Selecting and Arranging Diatoms.—Mr. J. Chalon lately described his method of selecting and mounting diatoms, before the Belgium Microscopical Society. He picks them up with a hog's bristle, 4–5 mm. in length, dipped in glycerin, which causes the frustules to adhere to the bristle. The cover-glass upon which the diatoms are to be arranged is coated with a thin layer of glycerin, by placing a drop of glycerin in 25 parts of alcohol upon it. The alcohol evaporates and leaves the glycerin. This retains the diatoms in place, and when all are arranged, the cover is heated to drive off the glycerin, when the diatoms remain firmly attached to the glass.

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Proceedings of the American Society of Microscopists. — The *Proceedings* of the fifth annual meeting, held at Elmira in August of this year, are already printed. They form a volume of 292 pages, with four plates. A good portrait of the late Charles A. Spencer forms the frontispiece. A general index to the transactions of all the preceding meetings has also been published.

The volume before us is a great improvement upon preceding ones. It shows great care in its preparation, and evidence that the work has been in competent hands. It contains a full and instructive account of the Elmira meeting. As an appendix to the address of the President of the Society, portions of which we have already printed, short notices of the lives of the celebrated manufacturers Tolles, Gundlach and Bulloch, and a historical notice of the Bausch & Lomb Optical Company are given. Prof. H. L. Smith's memoir of Charles A. Spencer is printed in full, and it is well worth reading. We cannot mention the titles of all the articles, but among them are the following: "On Light and Illumination," by E. Gundlach; "Observations on the Fat Cells and Connective-tissue Corpuscles of Necturus," with a plate, by Prof. S. H. Gage; "Stereoscopic Effects Obtained by the High-power Binocular Arrangement of Powell & Lealand," by A. C. Mercer, M. D., which is an article of considerable interest, in that the author endeavors to show why both ortho- and pseudo-scopic effects can be obtained with this instrument. Dr. F. M. Hamlin describes the "Wheel-like and Other Spicula of the Chirodota of Bermuda" in a very interesting way, showing that the form of the so-called wheels is not properly described in the books. The "Improved Griffith Club Microscope" is figured and described. Mr. H. Mills has an article on "Microscopic Organisms in the Buffalo Water Supply and in Niagara River" and Mr. C. M. Vorce contributes one on the forms found in Lake Erie, which has an illustrative plate with 83 figures. Dr. T. B. Redding's article on "Osmic Acid—Its Uses and Advantages in Microscopical Investigations," should serve to bring this valuable reagent into more extended use. Prof. T. C. Mendenhall gives an account of some measurements of a stage micrometer by Fasoldt, which shows very good spacing; but we would like to inquire how the Rogers micrometer, with which it was compared, happened to be such a very poor one? It looks very much as though no special efforts had been made to obtain a fair specimen of Prof. Rogers' work, and while it is true that the author states that "it does great injustice" etc., to Prof. Rogers, we still think it pertinent to inquire why the

measurements were published at all under such circumstances? Perhaps some one who knows will tell us whether that particular micrometer is the one that has been frequently used to demonstrate the imperfections of Prof. Rogers' rulings. If so, we might "a plain, unvarnished tale" unfold about that same micrometer. Mr. Henry Mills has a valuable article on the "Fresh-water Sponge." There are 178 names on the list of members.

The Society deserves to be congratulated for the thoroughness and promptness with which the Committee on Publication, consisting of Prof. Kellicott, Prof. McCalla and Mr. Fell, have done their work.

Copies of the *Proceedings* can be obtained, we presume, of Mr. Geo. E. Fell, at Buffallo.

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Sewer Gas.—Dr. Frank Hamilton has an article on sewer gas in *Popular Science Monthly*, of November, from which the following is taken:—

"This term has been employed a long time by chemists, sanitarians, plumbers, and others, to indicate the ordinary emanations from sewers; but recently certain gentlemen have taken exceptions to the term, denying that there is any such thing as sewer gas 'having a peculiar and definite composition.' This is undoubtedly true, and it is probable that no intelligent man or educated physician ever thought otherwise.

"What has been called 'sewer gas' is composed of air, vapor, and gases, in constantly varying proportions, together with living germs—vegetable and animal—and minute particles of putrescent matter. In short, it is composed of whatever is sufficiently volatile or buoyant to float in the atmosphere, and in consequence of which buoyancy it is permitted to escape through the various sewer outlets. The term is, in this sense, well understood; and it is, moreover, just as correct as would be the terms sewer vapor, or sewer air, which some have chosen to substitute for it.

"It is proper here to add that the offensiveness of odors is no test of their insalubrity, but that the most fatal germs are often conveyed in an atmosphere which is odorless. The absence of unpleasant odors, therefore, furnishes no proof that the air does not contain sewer emanations."

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A New Method of Attaching Objectives.—Mr. James L. Pease, of Chicopee, Mass., has constructed a nose-piece of new and ingenious design, intended to facilitate the attaching and detaching of objectives to and from the body of the microscope. Its operation resembles that of the self-centering chucks used by mechanics; the objective is held firmly as in a vise, and its centering is perfect. Changing objectives is accomplished with great rapidity and ease, without the troublesome screwing up and unscrewing.

The nose-piece can be applied to any stand having the society screw, no alteration of either stand or objectives being required. It is neat in appearance and not at all cumbersome, and adds but little to the length of the tube. It will be more fully described after we have had an opportunity to test it in practice.

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The Microbes of Disease.—Dr. D. E. Salmon spoke for a few moments at a recent meeting of the New York Microscopical Society, and incidentally made some allusions to some observations tending to cast doubt upon the supposed bacillus of tuberculosis. In his own experiments he found a diplococcus form in a rabbit which was affected with tubercular disease, which seemed to be the same as a diplococcus which had previously been described as the cause of tuberculosis. Koch had described a totally different form—a true bacillus. Later observers have failed to discover either form.

NOTES.

—We have had occasion recently to examine one of Messrs H. R. Spencer & Co's latest $\frac{1}{15}$-inch "professional" objectives, and we take pleasure in saying that it is one of the best high-power lenses we have ever seen. In the words of a competent judge its definition is "superb." It is not of very great angular aperture, being marked 100° B. A., but it will readily resolve all the diatoms of the test-plate, while it shows the podura-scale beautifully.

Of wide angle objectives, there are two $\frac{1}{8}$-inch lenses by Mr. Tolles, in this city, which give the finest resolution of *A. pellucida* that we have ever seen.

—We observe signs of growing interest in photographing with the microscope. Frequent inquiries about the best apparatus to be used, and concerning the practicability of photographing with high powers come to us from all parts of the country. We have already referred to the admirable arrangement for the purpose devised by the Scovill Manufacturing Company, and we have since learned from Messrs. J. W. Queen & Co. that they are making, or already have made, preparations to supply complete outfits for photo-micrography.

—Some "Notes on the Schizomycetes" by W. B. Grover, now being published in *Science Gossip* are well illustrated, and would prove of interest to many microscopists. They are written for the information of those who know nothing about these minute organisms, and the species are clearly described and compared with each other.

—O. Bütschli recommends the use of a solution of paraffin in chloroform (saturated at 35° C.) for imbedding delicate tissues. It possesses great advantages over the turpentine solution. The object to be imbedded is placed in chloroform, then in the solution, kept fluid by warm water, and when permeated by the paraffin, it is placed in a watch-glass with some of the solution and the chloroform driven off by heat. Then it can be imbedded in a larger mass of paraffin in the usual way.

—The angular aperture discussion bids fair to continue for some time yet in England. A few months ago Mr. George E. Davies wrote "A Plea for Wide Apertures," which was a reply to, and an able criticism from a practical point of view, of Prof. Abbe's recent article on the "Relation of Aperture and Power in the Microscope." At a meeting of the Manchester Microscopical Society, held September 7th, Mr. J. L. W. Miles read a paper on angular aperture, which has stirred up a real "hornet's nest." Mr. Davies declines to discuss the matter "in its present form," and it bids fair to become another warfare of personalities, such as the same subject has led to in the past. We very much fear that Mr. Miles will get the worst of the battle, but he is still confident and eager for the fray, for he proposes to meet his opponents in battle array at another meeting of the same Society.

—So far as we are aware, no fluid has yet been proposed for homogeneous immersion lenses equal to the oil of cedar. The objection to this is its extreme fluidity, and substitutes are therefore much used. It has been found that oil of cedar increases in consistency by exposure in thin layers to the air and sun. Its index of refraction is thereby raised to 1·520, but olive or castor oil can be used to bring it back to required index 1·510.

—The *Aulacodiscus Kittoni* is one of the beautiful discoid diatoms familiar to microscopists on the Pacific coast, and very common in cabinets everywhere. This diatom most frequently has four radiating processes, but often six, and abnormal forms are not rare. The number of rays is not characteristic of the species. Some time ago Rev. J. L. Mills had what he thought was an *A. Kittoni* with fourteen rays. Mr. F. Kitton, in examining this specimen, discovered that it was composed of two valves together, each having seven rays, the elevations of one fitting into the concavities of the other, thus giving the appearance of a single valve with fourteen rays.

—Mr. J. B. Schnitzler has made some observations on pollen grains, which certainly it would be interesting to repeat. He placed pollen grains of *Narcissus poeticus* and *Leucojum æstivum* in the mucilage obtained from the stems of the respective plants, and kept them at a temperature of 13 ° C. The pollen-tubes grow rapidly and currents of protoplasm are seen within them.

—The same author has observed some indications that *Palmella uvæformis* may, under certain conditions, develop into a filamentous alga resembling *Stigeoclonium*.

—*Wilford's Microcosm* is a monthly periodical, a copy of which has been on our desk for some time, awaiting examination. It purports to be a "religio-scientific monthly," and the publishers invite special attention to the "new and radical departures in science and philosophy" which have characterized it. We admit that if the articles on sound and gravitation in the number before us are fair exponents of the new departures spoken of, they deserve some attention from the scientific press. Not because they are valuable, but because, reaching as they doubtless do a large class of readers who have but a superficial acquaintance with science, such articles tend to cast discredit upon science. They are beyond criticism and unworthy of it. Their influence upon the progress of education is as pernicious as the effect of obscene literature upon morality. We can only express our sincere regret that such a paper as *The Microcosm* can find readers enough in the nineteenth century to make its publication possible; and this must be the feeling of every thoughtful person who has an interest in the advancement of knowledge and the education of the people.

CORRESPONDENCE.

TO THE EDITOR.—In the last number of your excellent JOURNAL, I observe reference made to mounting in balsam "by the carbolic acid process." As I presume many are ignorant, like myself, of the process, a brief explanation in your next number, would be read with great interest.

E. G. D.

[The process mentioned was fully described by Mr. Vorce, in the September number of Vol. I. That volume is now quite out of print, but a few copies of the September number can still be obtained.—ED.]

MICROSCOPICAL SOCIETIES.

At a meeting of the New York Society, held November 3d, Mr. J. D. Hyatt, described the structure of coral, and exhibited some sections of fossil coral which he had prepared, in which the coral skeleton had become changed from amorphous limestone into calcite, or crystalline carbonate of lime. The cells which were originally occupied by the coral animal were filled with crystals of quartz, and as the crystals were cut at various angles to their axes in making the sections, the latter showed very gorgeous colors with polarized light. One of the corals especially referred to, was *Columnaria alveolata*. He also showed a specimen of flint which he thought, from its microscopic structure, was originally a coral-rock. Flints are supposed to be usually derived from silicious sponges. In this specimen none of the lime carbonate of the coral remained, but the coral structure was preserved. The "table rock" at Niagara is limestone made exceedingly hard by silica. Some distance below the surface, where the silicification has not yet extended, the limestone is softer.

In reply to a question by Dr. Clarke, the speaker said that in some cases the calcareous coral substance is dissolved and replaced by silica. The silica is sometimes crystalline, sometimes amorphous.

Mr. N. L. Britton, referred to the Herkimer (N. Y.) limestone, in which *Columnaria* was abundant. Probably the specimens examined by Mr. Hyatt came from that formation, as great deposits of silica are found there. The silica was doubtless deposited from aqueous solution. In reference to this question, Mr. Kunz referred to deposits of chalecedony around sponges at Tampa Bay, where it is supposed the silica comes from silicious water from the land.

Mr. Kunz read a short article contributed by Mr. W. E. Damon, giving an account of his observations on coral animals in aquaria, which is published in another column.

At a meeting held November 17th, Polycystina and the Radiolaria in general, were the subject of discussion. Mr. Hitchcock spoke on the subject, giving a short account of the relations of those beautiful marine organisms to the Protozoa, and the Rhizopods in general.

One can scarcely speak of the Polycystina without first making some reference to the structure of the rhizopods in general. They are by no means all so simple in their structure as the primitive amœba, and even this minute spec of living protoplasm is far from being a structureless mass of living jelly, as it is frequently said to be. Yet the rhizopods occupy a very low position among the protozoa. Imagine a clear, transparent, colorless, semi-fluid substance, which has the power of moving, and you have an idea of the appearance of the simplest

amœba. But view this with a high power of the microscope, and at once it will be seen that it is not a perfectly homogeneous mass of matter. Throughout its substance there will be seen minute granules which seem to lie free in the more fluid portion, but which are not uniformly distributed through it. At some period of its life, it is probable that every amœba possesses a nucleus,—the function of which it is not possible to explain, but is supposed to be a portion of the protoplasm more highly organized than the rest. Advancing higher among the species we find a contractile vesicle, a clear circular spot or cavity in the protoplasm, which pulsates in a regular manner, as though it were alternately filled and emptied of a watery fluid.

Among the simplest and most minute forms, no definite external envelope can be discerned, but as we pass from these upward in the scale of development a thickening of the outer protoplasm is observed, which gradually becomes more and more pronounced until a well-defined enclosing membrane is found among all the more highly developed species. He then gave an account of the structure of the Radiolaria, their mode of growth, their food and methods of reproduction, and finally referred to the part they have taken in the formation of rocks. At Barbadoes their remains are found forming rock 1,100 feet in thickness, and at the Nicobar Islands, 2,000 feet.

Mr. Britton showed some Radiolaria dredged from 3,000 fathoms.

Mr. Balen showed some rotifers living within the sphere of *Volvox globator*.

NOTICES OF BOOKS.

A Sketch of the Progress of American Mineralogy. An adress delivered before the American Association for the Advancement of Science, at Montreal, August 23d, 1882. By Professor Geo. J. Brush, President. (Pamphlet, pp. 42.)

Ninth Annual Report Relating to the Registry and Return of Births, Marriages and Deaths in Michigan for the year 1875. By the Superintendent of Vital Statistics, under the general direction of the Secretary of State of the State of Michigan. By authority. Lansing: W. E. George & Co., State printers and binders, 1881. (Pp. 329.)

Tenth Annual Report Relating to the Registry and Return of Births, Marriages and Deaths in Michigan for the year 1876. By the Superintendent of Vital Statistics, under the general direction of the Secretary of State of the State of Michigan. By authority. Lansing: W. S. George & Co., State printers and binders, 1881. (Pp. 331.)

The compilation of these valuable books has involved an amount of labor which few persons can well appreciate until they make a study of the statistical tables. Yet the importance of the work cannot be over estimated, since it must lead to a better understanding of the laws which affect human health and happiness. It is to be regretted that all the States are not compiling annual statistics as carefully as the State of Michigan.

A Contribution to the Study of the Bacterial Organisms Commonly Found upon Exposed Mucous Surfaces and in the Alimentary Canal of Healthy Individuals. Illustrated by photomicrographs. By George M. Sternberg, Surgeon U. S. Army, etc. (Pamphlet, pp. 26, three plates.)

This is a valuable contribution, the subject of which is fully expressed by the title. It was read at the Cincinnati meeting of the A. A. A. S. last year. The plates illustrate two forms of apparatus used in culture-experiments, and a number of forms of bacteria found upon various mucous surfaces. The plates are by the heliotype process.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

WANTED—To exchange, good slides correctly named, or material for mounting for same.—F. C. Smith, Bridgeport, Conn.

WANTED—Diatomaceous material from New Hampshire containing *Amphipleura Lindheimeri*, in exchange for materials from North of Ireland.—William A. Firth, Whiterock, Belfast, Ireland.

Striatella unipuncta, *Rhabdonema Adriaticum*, and other first-class crude material, to exchange for named diatoms and first-class material—prepared and particularly foreign material preferred.—M. A. Booth, Longmeadow, Mass.

WANTED—Animal parasites, Ixodes, Acari, etc., either mounted or unmounted.—W. A. Hyslop, 22 Palmerston Place, Edinburg, Scotland.